MINISTRY OF AGRICULTURE AND FISHERIES

BULLETIN No. 1

SOME DISEASES OF FARM ANIMALS

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IMPERIAL BUREAU
OF ANIMAL HEALTH.

Some Diseases
of Farm Animals.

Pathology.

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SOME DISEASES OF FARM ANIMALS

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FOREWORD

IT is desirable that a central department, among whose functions are the investigation and control of diseases of animals, should be in the closest touch with stockowners, in order that the latter may keep the former fully advised of their special troubles, and that the former may disseminate the latest knowledge regarding these troubles and their prevention. One method which the Ministry has adopted for the dissemination of knowledge is the publication of leaflets, but, useful as this method certainly is, it should not be thought that the leaflets are intended to supply anything more than a general outline of the subject treated. This Bulletin consists of an ordered arrangement of leaflets at present issued, but it is probable that certain of the subjects herein treated will in the future be dealt with in individual Bulletins.

Regard being had to the fact that successful treatment and prevention depend on early and accurate diagnosis, the attention of stockowners is specially drawn to the description of symptoms and post-mortem appearances upon which a diagnosis can be made. Stockowners have the animals under their eye, and are, therefore, in the best position to suspect illness at its start. The information contained in this Bulletin is intended to assist in this respect, but does not aim at giving a complete description of methods for dealing with the conditions referred to. Stockowners should rely upon the advice of their veterinary surgeons in controlling and treating illness in their animals.

Readers will readily understand that, as fresh knowledge on various diseases continues to become available, it is not always possible in a volume of this kind for each subject to remain rigidly up-to-date.

In the sections dealing with certain contagious diseases, reference is made to treatment with appropriate sera or vaccines. It will be convenient in this foreword to describe these preparations in general terms and their use in practice. The terms *serum* and *vaccine* are not interchangeable, but on the contrary refer to products which are totally different and which are designed to meet entirely different circumstances.

A *serum* is prepared from the blood of an animal which has been immunized against a particular disease to such a degree that it is capable of withstanding very large doses of the organism causing the disease. The *serum* of the blood contains the protective properties produced by the system whilst reacting to the disease organisms. When injected into another animal the serum will confer immediate protection against the

particular disease, but the immunity is temporary, lasting for about ten days only, and will disappear when the protective properties are diminished. The serum, however, is usually curative and may be administered to ailing animals. These, after recovery, will have a lasting immunity since, in the course of the attack, the system will have produced its own protective bodies without relying entirely upon those introduced into it.

A *vaccine* consists of the actual organisms—sometimes dead, sometimes alive—which are responsible for a particular disease. Where a live vaccine is used, the organisms have usually been treated so as to reduce their virulence, as far as possible, consistently with their capacity to stimulate the defensive forces of the system to produce protective bodies against the organisms. As the system produces its own protection, an animal treated with vaccine is not immunized immediately on inoculation: a week or a fortnight will elapse before immunity is established, but the immunity will last for some months or even years.

It is important that the distinction between the two processes should be appreciated. In the presence of a given disease, when cases of illness or death have already occurred, serum may usefully be administered either curatively to ailing animals or to induce protection during a short period. On the other hand, if losses from a disease are regularly experienced, inoculation of vaccine may be practised during a period of quiescence or before animals are exposed upon dangerous ground. The far-sighted policy of vaccination is preferable to delayed intervention when cases of the disease have arisen, assuming that normal losses are sufficient to warrant the expense involved.

It is unnecessary and, in the case of live vaccines, undesirable to vaccinate animals against a disease which has not previously occurred on the farm, and vaccination against acute diseases should not be resorted to in the case of animals which are in contact with diseased animals.

Particulars of treatment by appropriate serum or vaccine will be found under individual subjects. Owners contemplating the use of these preparations should consult their veterinary surgeons, to whom administration should invariably be entrusted.

For convenience of reference the subjects are arranged in alphabetical order.

P. J. L. KELLAND,
Chief Veterinary Officer.

10, Whitehall Place,
London, S.W.1,
June, 1934.

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SOME DISEASES OF FARM ANIMALS

THE DISEASES OF ANIMALS ACTS, 1894 TO 1927

The suppression of contagious and infectious diseases in animals is of primary importance to the agricultural industry of every country, and practically all countries have adopted measures of some kind for that purpose.

Records exist of serious loss suffered for several centuries past from animal epidemics, but no organized attempt at control was made in Great Britain until 1848, when the prevalence of sheep-pox, introduced from the Continent, led to the passing of two Acts of Parliament under which that disease and the cattle-plague outbreaks of 1865 were dealt with. These Acts proved insufficient to prevent the spread of cattle-plague throughout the country until the Cattle Diseases Prevention Act, 1866, was passed; this required the compulsory slaughter, with compensation, of all affected animals, and empowered the slaughter of animals in contact therewith. This measure succeeded in eradicating the disease by September, 1867, and the experience of these two diseases led to the passing of the Contagious Diseases (Animals) Act, 1869, which conferred extensive powers upon the Privy Council and Local Authorities to deal with animal diseases, including pleuro-pneumonia and foot-and-mouth disease, as well as cattle-plague and sheep-pox. The Act of 1869 also imposed the first effective restrictions on the importation of animals from certain foreign countries where disease was prevalent. Agricultural opinion was not, however, favourable to the full exercise of the powers conferred by the Act of 1869, and the country had to experience two more outbreaks of cattle-plague (1872 and 1877), and very extensive outbreaks of foot-and-mouth disease and contagious pleuro-pneumonia of cattle, before the Act of 1869 was revised by the Contagious Diseases (Animals) Act, 1878, which laid the foundation for the methods now in force. The Act of 1878 and its subsequent amendments were consolidated by the Diseases of Animals Act, 1894, which, with its nine amending Acts of 1896 to 1927, confers the powers upon which State action at the present time is based.

Main Objects of the Acts: Central and Local Organization.—Generally speaking, the Acts impose upon the Minister of Agriculture and Fisheries, as the central authority, the duty of devising and putting into operation measures for the control and eradication of contagious diseases amongst animals in England,

Wales and Scotland. They confer upon the Minister wide powers to make Orders for these and other specified purposes, including:—

(*a*) The declaration of infected places and areas;

(*b*) The prohibition or regulation of the movement of animals into, out of, or within such places and areas, and of the exposure of animals at markets, sales and exhibitions;

(*c*) The control of the importation of foreign animals, carcasses, fodder, etc., for the purpose of preventing the introduction of disease from without;

(*d*) The muzzling and control of dogs; and

(*e*) The protection of animals and poultry from unnecessary suffering during transit by land or sea.

Thus, while indicating the general lines of the procedure to be adopted, the Acts empower the Minister to prescribe the details by administrative Orders which have the full force of an Act of Parliament.

For the discharge of these duties the Minister has established the Diseases of Animals Division of the Ministry, under the direction of the Chief Veterinary Officer, assisted by a professional staff consisting of a Deputy Chief Veterinary Officer, 7 Superintending Inspectors, 31 Divisional Inspectors and 61 Inspectors, and also by a lay administrative and clerical staff numbering 43. The professional staff is distributed between the head office, general field work, inspection of animals at ports, and the Ministry's Laboratory.

With certain exceptions, the Acts require the Local Authorities and the police generally to execute and enforce the provisions of the Acts, and of the Orders of the Minister thereunder. The Local Authorities constituted for the purposes of these Acts number 324, and comprise the County Councils, the County Borough Councils and the Councils of certain other boroughs and burghs. All these Authorities are required to appoint their own veterinary and other inspectors to carry out the duties imposed upon them, and the expenses of the Local Authorities, with certain exceptions, have to be defrayed out of the local rate. In most of the counties the police have been appointed as Inspectors. An Inspector of the Ministry or of a Local Authority has special powers of entry upon any premises or on any vessel on which he has reason to believe that disease exists, or that the Acts or Orders of the Minister, or the Regulations of a Local Authority, are being infringed. In addition, an Inspector of the Ministry may enter any premises to ascertain whether pleuro-pneumonia, foot-and-mouth disease or swine fever exists thereon.

Diseases dealt with under the Acts.—The Acts and Orders of the Minister at the present time require the notification of cases or suspected cases of the following twelve diseases: cattle plague, contagious pleuro-pneumonia of cattle, foot-and-mouth disease, sheep-pox, swine fever, sheep scab, anthrax, rabies, glanders, epizootic lymphangitis, parasitic mange in horses, asses or mules, and certain forms of bovine tuberculosis. These may be divided into two classes:—

(1) Those in which the diagnosis is in the hands of the Ministry's officers, i.e., cattle-plague, pleuro-pneumonia, foot-and-mouth disease, sheep-pox and swine-fever; and

(2) Those in which the diagnosis is carried out primarily by officers of the local authorities, i.e., anthrax, sheep scab, glanders, rabies, epizootic lymphangitis, parasitic mange of equines and bovine tuberculosis. In anthrax and rabies, however, the diagnosis is subject to confirmation by the Ministry, and in sheep scab, glanders and tuberculosis the owner has a right of appeal to the Ministry against the diagnosis.

Of the above diseases, no outbreaks have occurred in Great Britain, of cattle plague since 1877, pleuro-pneumonia since 1898, sheep-pox since 1850, epizootic lymphangitis since 1906, or of rabies since 1922. The efforts of the Authorities are therefore directed mainly against other diseases.

Responsibilities of Stockowners and Veterinary Practitioners: Reporting of Disease and Separation of Affected Animals.—Every person having in his possession or under his charge an animal or carcass affected with or suspected of any of the notifiable diseases above-named is required:

(*a*) As far as practicable to keep that animal or carcass separate from animals not so affected; and

(*b*) With all practicable speed to give notice, to a police constable, of the fact that the animal or carcass is so affected or suspected.

Section 57 (1) of the Act of 1894 provides that the owner or person in charge of an animal, charged with an offence against the Act relative to disease, shall be presumed to have known of the existence of the disease or illness unless and until he shows to the satisfaction of the Court that he had not knowledge thereof, and could not with reasonable diligence have obtained that knowledge.

Any veterinary surgeon who finds any notifiable disease is likewise required to report such cases to the Local Authority.

An important provision contained in the Orders of the Minister dealing with the specified diseases is the prohibition of the exposure of any affected or suspected animal in a market, fairground, sale yard or place of exhibition, and of the movement or grazing of such an animal on a highway, road or lane,

or on common or unenclosed land, or of its movement by rail or water.

The Acts and Orders impose upon stock-owners and the public generally an obligation to afford inspectors and police all necessary facilities for the performance of their duties, and any obstruction is an indictable offence. Persons guilty of an offence in respect of these or other matters referred to in the Acts and Orders are liable to a penalty of £50, or £5 in respect of each animal where more than 10 animals are concerned, and in certain cases to imprisonment.

Slaughter and Compensation: Remedial Treatment.—In the case of cattle plague and pleuro-pneumonia, the Acts render it obligatory upon the Ministry to slaughter all affected animals, with payment of compensation. In the case of sheep-pox, slaughter by the Local Authority is compulsory.

In foot-and-mouth disease, slaughter is not obligatory, but may be carried out at the discretion either of the Ministry or of the Local Authority. In practice, in cases of foot-and-mouth disease, slaughter of affected and in-contact animals accompanied by stringent restrictions on movement of animals in affected areas, is adopted by the Ministry as being the most effective and economical method of maintaining the comparative freedom of this country from the disease, regard being had to present pathological knowledge. This disease is the subject of investigation by a Scientific Research Committee appointed by the Minister of Agriculture.

In the case of swine fever also, slaughter is within the discretion of the Ministry. As a "stamping out" policy, slaughter in swine fever was given a prolonged trial over many years at considerable public expense, but without success. The attempt to stamp it out was abandoned in 1915 in favour of control by isolation of infected herds, and slaughter is now carried out only where necessary to provide a means of diagnosis by post-mortem examination.

Of the other notifiable diseases, slaughter of affected animals is obligatory upon the Local Authority in cases of glanders and certain forms of bovine tuberculosis, with compensation to the owners; and also of dogs and cats (but without compensation) found to be affected with rabies, or known to have been bitten by a rabid dog or cat.

Cases of sheep scab and parasitic mange in equines are dealt with by the application of remedial measures; sheep scab by the dipping of the affected sheep twice with a short interval (not less than 7 days and not more than 14 days) between the two dippings; and mange by a dressing or other

remedy approved by a veterinary surgeon. Anthrax in animals is nearly always fatal, and slaughter is expressly avoided, as the spilling of the blood, which swarms with anthrax bacilli, is attended with great danger both to other animals and human beings. All stockowners and butchers are cautioned against the cutting of the carcasses of animals which have died of anthrax or suspected anthrax. Cremation is the usual method of destruction of the carcasses.

The above measures are accompanied in every case by restrictions on the movement of the animals on the infected premises, with the object of preventing the spread of infection to other stock.

Principles of Compensation.—The amount of compensation payable for animals slaughtered by the Ministry or Local Authority varies with the disease and according to whether the animal is diseased or not. The object of the provision made in the Act of 1894 for the payment of compensation is frequently misinterpreted. Compensation is not provided for the purpose of reimbursing an owner for losses incurred through outbreaks of disease amongst his stock; such losses are ordinary trade risks connected with the live stock industry, and are to some extent insurable. Compensation is provided to enable the Ministry or Local Authority compulsorily to acquire the ownership of any animals which it considers should be slaughtered in the public interest. These animals become the property of the Ministry or Local Authority, and the owner is paid compensation according to a prescribed scale based upon the market value of the animals when slaughtered. The Ministry and the Local Authority have power, however, to withhold compensation either wholly or partially, in respect of an animal slaughtered under the Acts and Orders where the owner or person in charge of the animal has, in the judgment of the Ministry or the Local Authority, as the case may be, been guilty, in relation to the animal, of any offence against the Diseases of Animals Acts or Orders made thereunder. This power to withhold compensation is sometimes exercised, more particularly in cases in which the owner or person in charge has been convicted for the very serious offence of failing to report disease.

Other Diseases: Provision for Research.—The Act of 1894 empowers the Minister, by Order, to add other diseases to the list of those to be dealt with by State action. Some of the more serious diseases in animals, such as contagious abortion in cattle, Johne's disease, etc., are not suitable for

addition to the list of notifiable diseases, either because the nature of the disease renders this impracticable, or because the imposition of such measures of control as would be necessary would interfere unduly with the industry and thus make the remedy worse than the disease. Such diseases, therefore, are not notifiable, but the more important are dealt with in leaflets of advice which are available for the use of farmers.

In addition, scientific research is conducted into various contagious and infectious diseases of animals, including foot-and-mouth disease; contagious abortion in cattle, mares and ewes; various sheep diseases, such as louping ill and scrapie; tuberculosis; Johne's disease; mastitis in cows; quarter evil in cattle, etc. These researches are conducted either at the Ministry's Veterinary Laboratory (New Haw, Weybridge, Surrey) or at various institutes aided by Government grants.

Measures for Preventing Introduction of Infection from Abroad.—One of the most important aspects of the problem of keeping Great Britain free from disease is the prevention of the introduction of disease from abroad. Our insular position gives us special advantages in this respect, but these are limited by the fact that we are not self-supporting either in regard to foodstuffs or various raw materials for manufacture, etc. Without undue interference with these necessities, it has been possible to provide a considerable measure of protection against the introduction of infection by live animals, carcasses, hay, straw, packing materials and animal foodstuffs by the following action:—

(i) Prohibition of landing of live cattle, sheep, goats, and swine from abroad, except—

(*a*) From Ireland, the Channel Islands and the Isle of Man, subject to certain conditions;

(*b*) Canadian store cattle for feeding purposes, subject to the provisions of the Act of 1922, and

(*c*) Fat cattle or sheep from Canada, the United States, the Union of South Africa (including the Mandated Territory of South West Africa), Southern Rhodesia, Iceland and the Faroe Islands, subject to slaughter at an imported animals' wharf at the port of landing within 10 days after landing.

(ii) Prohibition of the landing of fresh carcasses and animal products from the Continent of Europe, with certain minor exceptions.

(iii) Prohibition of landing of hay and straw from countries infected with foot-and-mouth disease.

(iv) Requirement that packing materials used for goods and meat, whether imported or not, shall not be brought into contact with animals and shall be destroyed when their use as packing material is finished.

(v) Requirement that all waste animal foodstuffs or swill containing animal matter, whether of foreign or home origin, shall be boiled before being fed to or brought into contact with animals.

(vi) Prohibition of landing of dogs and cats and other canine and feline animals from abroad, except by licence from the Ministry and subject to six months' quarantine on approved premises, as a protection against rabies.

(vii) Control of importation of horses, asses and mules, which are required to be accompanied by a veterinary certificate in specified terms, as a protection against glanders, epizootic lymphangitis, dourine, and certain other diseases of equines.

Protection of Animals and Poultry from Avoidable Suffering during Transit.—In addition to the measures above described for the suppression and prevention of animal diseases, the Ministry is charged under the Diseases of Animals Acts with the duty of making such regulations as may be considered necessary for protecting animals and poultry from avoidable suffering during transit on land or by sea, and for securing to them a proper supply of food and water. Orders with this object in view have been made as follows:—

(*a*) Transit of Animals Order of 1927, dealing with the carriage of animals between ports in Great Britain and between Great Britain and Ireland, the Channel Islands and the Isle of Man, and also the carriage of animals by rail in Great Britain. This Order includes requirements as to the nature of the fittings for vessels engaged in the trade, and also the construction of railway vehicles carrying animals by railway.

(*b*) The Transit of Animals (Amendment) Order of 1931, imposing certain requirements regulating the method of construction of motor vehicles used for the carriage of animals by road.

(*c*) The Animals (Sea Transport) Order of 1930, which prohibits the carriage of animals on open main (freeboard) decks during any part of the year, or (with certain exceptions) on any deck unless completely closed in at the sides and covered with a permanent deck above.

(*d*) Conveyance of Live Poultry Order of 1919, to protect live poultry during transit by sea, road or rail, or during exposure for sale, from exposure to bad weather or excessive heat, and to prevent overcrowding or the use of unsuitable receptacles.

(*e*) The Exportation and Transit of Horses Order of 1921, which regulates the traffic in horses exported to the Continent or elsewhere, prevents the export of decrepit horses, i.e., horses unfit to travel or work, lays down stringent provisions as to the construction of the stalls in which the horses are to travel, and requires the provision of an adequate supply of food and water at all stages of the journey.

The Dogs Act, 1906.—Section 2 of the Act of 1906 is the only part of the Act with which the Ministry is directly concerned as the administering authority. That section adds to the

purposes for which the Ministry may make Orders under the Diseases of Animals Act, 1894, the following:—

(*a*) For prescribing the wearing by dogs, whilst in a highway or place of public resort, of collars bearing the name and address of the owners; and

(*b*) For preventing dogs from straying during the hours of darkness, the object being to prevent the worrying of cattle and sheep.

Collar Regulations are now in force throughout Great Britain, and by the Control of Dogs Order of 1930, Local Authorities are empowered to make regulations requiring dogs to be kept under adequate control during the hours of darkness. These powers have been exercised in nearly every county in Great Britain.

ACORN POISONING

The Ministry considers it desirable to warn stockowners who are accustomed to turn cattle into parks, or on to commons, or other places where acorns are plentiful, that there is considerable risk of injurious effects arising from the consumption of large quantities of acorns, which are certain to be eaten with avidity.

In the years 1868, 1870, 1884, 1900 and 1933, which were remarkable for a large yield of acorns after a long, dry, and hot summer, serious losses among young cattle occurred from outbreaks of what is known as the "acorn disease," or acorn poisoning. In many districts, notably in Middlesex, Kent, Hertfordshire, Warwickshire, Lincolnshire, Northamptonshire, Wiltshire, Gloucestershire, Devonshire, the New Forest, Sussex, Surrey, Suffolk, Norfolk, and Derbyshire, heavy losses were experienced. Young cattle up to two years old suffered most severely. Milch cows and cattle over three years old were seldom affected. Sheep and pigs appeared to be insusceptible to the poisonous action of the seeds, and only two or three cases were reported in these animals, while entire herds of young cattle were attacked and a large proportion of them succumbed. In cases that have occurred in the New Forest recently, the affected animals were mature cows.

Acorn poisoning is not quite distinct from what appears to be indigestion due to eating an excessive quantity of acorns. This accidental disorder may occur in ordinary seasons when animals are first allowed access to pasture where acorns abound. Acorn disease may be accompanied by progressive wasting, entire loss of appetite, constipation followed by diarrhœa, discharge of an excessive quantity of pale urine, sore places inside the mouth, discharge from the nostrils and also from the eyes, which are always sunken and thus give to the animal a peculiar, haggard expression. No fever is present from first

to last, but, on the contrary, the temperature is commonly below the normal standard.

On post-mortem examination it is sometimes found that all traces of the acorns have disappeared. The morbid changes are an inflammatory condition of the stomach and bowels.

There is no specific remedy, but purgatives and demulcents are useful; professional advice should be sought. Prevention is comparatively easy when the risk is realized. For absolute security cattle must be kept from the pastures while acorns are falling. The danger will be materially lessened by collecting the acorns from the pastures, but this device does not prevent a considerable consumption of the nuts that fall during the night. If swine are allowed access to pastures on which acorns fall they will devour large numbers, on which they will thrive well, and, at the same time, proportionately reduce the quantity within the reach of cattle. It has also been suggested that when cattle are allowed access to acorns during the daytime only they should be supplied with a liberal allowance of food before they are turned out.

ACTINOMYCOSIS AND ACTINOBACILLOSIS IN CATTLE

(Lumpy Jaw and Wooden Tongue)

Actinomycosis and Actinobacillosis are met with in most parts of Great Britain, cases being referred to under such popular names as Lumpy Jaw, Big Head, Hard Tongue, Wooden Tongue, Wens, etc. In this country cattle principally are attacked, but infection may occur also in pigs, sheep, horses and man.

These diseases run a chronic course, extending over a period of months or even years, and are characterized by the formation of tumours in various parts of the animal body. These tumours interfere with the functions of the organs in which they are situated, and may ulcerate or burst and discharge pus containing " granules ". If not treated, the affected animal steadily wastes away, especially if the tongue or lips or bones of the jaw are affected, and it may eventually die from malnutrition.

Cause.—In this Bulletin the word Actinomycosis is used in the restricted sense of the term to include only the disease caused by the entrance into the animal, and the propagation in its tissues, of the parasitic Ray fungus, *Actinomyces bovis*. This fungus grows on grasses and most cereals, particularly barley, flourishing on damp rich soils. Injuries to the skin and to the mucous membranes of the mouth and tongue, caused by hard

straws or barley awns, as well as the teething troubles of young animals, predispose cattle to this disease by favouring the entrance of the Actinomyces to the tissues, though the barbed barley awns may penetrate healthy tissue and, if infected with spores of the fungus, set up the disease in their tracks.

Actinobacillosis is a condition in which lesions are produced that resemble those of Actinomycosis, but which are caused through infection by a different organism, the *Actinobacillus lignièresi*. The infective agent appears to enter by way of the digestive tract.

In Actinomycosis the lesions usually involve bony tissues, e.g., the jaws, whereas in Actinobacillosis the lesions are found most frequently in the soft tissues of the head and neck, e.g., the tongue, glands and skin.

Symptoms.—Infection in cattle is usually confined to one organ of the body, and the part attacked largely determines the symptoms and the gravity of the condition. Nodules of varying sizes may form on the skin of the head and neck, at times being firm to the touch, while sometimes the skin is broken and the nodules are granular, soft, yellowish in colour, and covered by a crust. The skin covering the lips, being very liable to injury, is frequently attacked, the lips then becoming hard and enlarged to such an extent that food is gathered with difficulty—especially is this so when the tongue is affected—and great wasting occurs.

The tongue is the most common seat of the infection. The presence of the organism excites a growth of fibrous tissue, causing the tongue to become hard and immobile, hence the name "wooden tongue." This gives rise to a constant dribbling of saliva, and on examination of the mouth, the affected part of the tongue is found to be hard; this and the presence of ulcers on its surface, most frequently at the food cavity in front of the thickened portion at the back of the tongue, render this form of the disease easy of diagnosis.

Tumours can sometimes be felt under the skin in the muscles of the cheeks. The jaw bones, usually the lower, may be invaded by the parasite through the soft tissues of the mouth and possibly through the sockets of the teeth. Great swelling of the attacked bone is noticed, and the head sometimes swells to a great size. Pus collects in cavities in the bone, eventually breaking through the skin, and forming wounds which constantly discharge. In this condition the jaw is easily fractured and the teeth drop out.

A very common form is met with when the glands of the neck are affected—a swelling or "wen" appears between

the angles of the jaw, which steadily increases in size until breathing and swallowing are interfered with. These tumours often burst and discharge a characteristic, granular, yellow pus.

The presence of tumours (*polypi*) attached to the mucous membrane of the back of the throat can often be recognized by the snorting grunt that accompanies breathing, and by the difficulty in swallowing.

Prevention and Treatment.—In this country no evidence is forthcoming that infection has ever been disseminated on a hitherto clean farm by the importation of affected animals; nevertheless, it is not advisable to introduce a diseased animal among a clean herd.

In districts where the Actinomyces flourish it is almost impossible to prevent animals being attacked; the spores of the fungus are very resistant and survive for a considerable period in dry surroundings, whilst moisture encourages their growth. There is no practicable method of destroying the parasite in fodder or straw in bulk.

Drainage of land is said to have diminished the number of cases by checking the growth of the fungus.

Although the fungus grows on a number of plants, barley straw is principally responsible for conveying the disease to cattle and, if it must be fed to stock it should not be given to young animals when their teeth are changing as the parasite then has an excellent opportunity of entering the tissues through the gums, and setting up disease in the jaw-bones, which, in this situation, is difficult to eradicate, particularly when well established.

In districts where Actinobacillosis occurs, there are no known methods of preventing the infection of susceptible animals.

Farmers who have cattle showing suspicious symptoms should consult a veterinary surgeon. Affected animals should be isolated.

Although prevention is difficult, these conditions respond to treatment with mercury and iodide of potassium. Whenever possible, the tumours caused by the disease should be removed by a veterinary surgeon. When their position renders an operation impossible, medicinal treatment will generally check or cure the disease. Treatment should be attempted only by a skilled surgeon, as the tumours have usually to be removed from the region of the head and throat, while the success of the medicinal treatment depends on giving iodide of potassium under expert supervision until symptoms of poisoning by this drug appear, when its administration must immediately be stopped.

ANTHRAX

Anthrax is a contagious disease caused by a microbe *Bacillus anthracis*. Human beings and all animals are liable to become infected. The disease, which shows itself suddenly, chiefly attacks cattle, then pigs, but horses are not uncommonly affected. It is often very quickly fatal, usually within forty-eight hours of illness showing itself, but in the United Kingdom is does not often spread with rapidity from animal to animal, though it may affect a number of swine at the same time if they have been fed on flesh affected with anthrax.

Symptoms.—Where an animal is attacked with anthrax its inclination is to separate itself from its companions. It stands almost immovable, with head depressed, and usually at the later stages of the disease declines every kind of food. If the animal is carefully watched, rigors, or shivers, will be seen to pass over the body; the temperature is raised; there may be swellings (around the throat—especially in horses and pigs) which are very hot to the touch, the eyes have a fixed and staring look, and, if carefully looked for, a small quantity of blood may sometimes be found trickling from the nose, or upon the voided fæces of the living animal. Death follows as a rule very rapidly after these symptoms are observed.

Post-Mortem Appearances of the Disease.—Where an animal dies of anthrax there is generally, though not always, to be found almost directly after death a slight oozing of blood from the nostrils or some other of the external openings of the body. The carcass is swollen. The muscles may be infiltrated with blood at certain points. The lungs and glands are congested. The spleen is very much enlarged; it is softer and darker than normal and its substance usually resembles tar.

In most parts of this country the enlargement of the spleen in cattle is of great diagnostic importance, but in those districts where Redwater exists, enlargement of the spleen may be due to this disease and not to anthrax. In such a case, however, the spleen substance has not the same fluid, tarry appearance. In horses and pigs, and much less frequently in cattle, the spleen may be of normal size, although the animal has died of anthrax. The flesh is dangerous to animals and man.

Difficulty of recognizing the Disease.—One of the greatest of the difficulties which present themselves in dealing with this disease is that the symptoms during life are not such as to lead a person who is unacquainted with anthrax to suspect the presence of the disease. Moreover, the death of the animal

attacked often occurs when the owner or attendant is absent. It frequently happens that an animal which has sickened is killed, or that the carcass of an animal dead of anthrax is cut up, and the blood, which is the main source of danger, is freely spilt about the premises or on the soil. The disease is in this indirect manner spread to other animals, and in some cases the persons who have handled the carcass are affected. In every case of sudden and unaccountable death amongst stock, the owner of the animal should await a skilled opinion before disposing of the carcass.

Anthrax or Suspected Anthrax to be Reported.—Every person in Great Britain having or having had in his possession or under his charge an animal (that is, a ruminating animal, pig, horse, ass, mule, or dog, and any four-footed mammal kept in captivity) affected with or suspected of anthrax, is required by law to give notice of the fact with all practicable speed to the Police. Failure to give such notice renders a person liable to a fine of £50, and in certain circumstances to a month's imprisonment with hard labour.

It is the duty of the Local Authority under the Diseases of Animals Acts on receiving such notice to institute inquiries and to make proper provision for the disposal of the carcass of any animal suspected of anthrax, and for the disinfection of the premises upon which disease has existed or is suspected to have existed. The Inspector of the Local Authority is also required to give information to the Medical Officer of Health.

Precautions to be Taken.—An owner of animals can do much to assist in preventing the spread of the disease amongst his stock, and it is clearly to his own interests that he should do so.

A sick animal should on no account be killed, but should be carefully isolated from all other animals. Should there be the slightest suspicion of anthrax, the matter must, as before mentioned, be reported to the Police, and in the event of such an animal dying before the arrival of the veterinary surgeon employed by the Local Authority, the carcass must not be dragged along the ground, but should be allowed to remain where it is, until the examination has taken place. It is essential that *the carcass of the animal should not be cut or opened,* and steps should be taken to prevent the escape of blood or of excretions which may contain blood. Any such blood should at once be destroyed and also any drops of blood which may have escaped from the carcass to the floor of the shed or to the soil, inasmuch as every drop of blood of an animal which has died of anthrax contains large numbers of the bacilli which cause the

disease, and from these, very resistent spores may form. For the purpose of destroying the bacilli contained within the infected blood a strong solution of carbolic acid should be used, and all the external openings should be plugged with hay saturated with the same solution.

Under the Anthrax Order of 1928, various provisions are required to be observed in connexion with cases, or suspected cases, of anthrax, and it is advisable therefore that stock-owners, butchers, and other persons dealing with animals should make themselves fully acquainted with these provisions, as any failure to observe them may render the offender liable to legal proceedings. The following provisions may, however, be quoted here.

Under the Order, the occupier of any premises on which there is a diseased or suspected animal or carcass must—

(i) prevent access of animals or fowls to the diseased or suspected animal or carcass, or to any part of the premises which has been exposed to infection of disease from the animal or carcass; and

(ii) detain on the premises any diseased or suspected animal thereon and any other head of cattle, or sheep, or goat, or swine which has been in the same shed, stable, building, yard or field with the diseased or suspected animal or carcass.

(iii) not cut the carcass.

The occupier is also required to disinfect as soon as possible, with an approved disinfectant, any place where the carcass of a diseased or suspected animal has lain or where its blood has escaped.

A diseased or suspected carcass must not be buried or destroyed otherwise than by the Local Authority, or be removed from the farm or premises upon which the animal died or was slaughtered, except by the Local Authority.

Animals with which a suspected animal has been in association should be carefully watched, and isolation at once adopted in the case of the appearance of symptoms similar to those of the suspected animal. Such precautions are particularly necessary in the case of milch cows affected or suspected of being affected. The milk of these cows may contain anthrax bacilli, and so be the means of infecting human beings. Article 3 (3) of the Anthrax Order prescribes that the milk produced by any diseased or suspected cow or goat shall not be mixed with other milk, and that all milk affected by the provisions of that Article shall forthwith be boiled or otherwise sterilized, and

any utensil in which such milk is placed before being so treated shall be thoroughly cleansed with boiling water before any other milk is placed therein.

General Observations.—It is important that it should be widely known that anthrax is due solely to the introduction of the minute germs or spores of anthrax into the blood of an animal or of man. The disease may therefore be introduced by any medium capable of conveying these germs or spores. Feeding stuffs brought on to a farm, or manures made from animal substances, may be vehicles of infection. If a stream becomes contaminated, as has been found to be the case where certain industries, involving the use of the hides, hair, &c., of animals, are carried on, the spores may be carried to the farm by the water. The spores of anthrax develop into bacilli which find their way into the circulation of an animal through a cut or abrasion. In an affected animal the germs are present in the form of bacilli; every bacillus, under favourable conditions, is capable of developing into a spore, and a spore can retain its vitality for many years; on entering the body of an animal it resumes the bacillary form and multiplies with great rapidity.

Where infection has once been introduced upon a farm it has frequently been continued by the ignorance or carelessness of individuals, and in some cases farms have become permanently infected with anthrax.

It is a common practice amongst owners of stock to slaughter their cattle as soon as they present symptoms of serious illness, in order that the carcass and hide may be utilized. Where, as is not uncommonly the case, the sudden illness is due to the presence of anthrax, the greatest mischief is done by such a practice. The blood of the diseased animal is distributed on the ground, or it may be on the floors of the cattle shed or upon the mangers, or is carried on the boots of the attendants to other parts of the farm or premises. The bacilli contained within the blood of a diseased animal may, when exposed to the air, produce spores which may become the means of infecting other animals at short or long intervals. Many cases have come under the notice of the Ministry from time to time of persons having contracted anthrax whilst engaged in slaughtering ailing animals, or in dressing or otherwise handling the carcasses of diseased animals.

On the other hand the bacilli of anthrax die *if kept within the intact carcass* of an infected animal; no spores are formed; and experience has shown that, where the precautions recommended above have been scrupulously adhered to, the disease frequently ceases after the death of one animal on the farm.

Preventive Inoculation.—The Pasteur method of preventive inoculation has rendered great service in preserving stock on badly infected farms in various parts of the world. The method consists of injecting the animals with fixed doses of attenuated cultures of the *Bacillus anthracis*. Two injections at intervals of 12 days are performed. For the first injection a very attenuated culture is used (first vaccine), and for the second, a less attenuated culture (second vaccine) is employed. The immunity is established about 12-15 days after the second vaccine has been injected. In cattle it lasts about a year, and should be repeated after this period unless the ground has become purified. The great majority of cattle operated on show little more than a temporary indisposition with passing fever after the injection, which may be asumed to indicate a mild attack of anthrax. Occasionally, however, an inoculated animal may die of the disease as the result of the injection, and for this reason the animals while undergoing the process of immunization should be kept in a special paddock, or better still in sheds which can be disinfected in the event of an accident taking place. The operation should only be attempted by skilled persons, who will know the best way to prevent an accident, and guard against its consequences should it occur.

Since the operation is not altogether unattended by the possibility of loss, and since it incurs a certain amount of expense, one has to consider under what circumstances it will be worth while undertaking it. It will be obvious that on farms registering only one death annually it will hardly be called for and that it would be folly to adopt it on clean farms.

From observations on several millions of cattle in various parts of the world it is deduced that accidents occur in about 0.5 per cent. of the inoculated cattle taken all round, and that the operation may be expected to reduce the death rate from anthrax on infected farms to about 1 per cent. or slightly under.

If a stockowner finds that his annual losses from anthrax amount to 2 per cent. he will possibly find it profitable to have recourse to preventive inoculation.

It should be understood, however, that since the number of animals dying of anthrax in one year will vary, and since the inoculation must be repeated annually, the estimation of annual losses must be based on two or three years' casualties.

A certain degree of temporary immunity can also be conferred almost immediately by injecting a dose of anthrax serum, and the injection produces no accidents. The serum also has curative properties and may be administered to clinically-

affected animals. Where animals have been exposed to the risk of what might be called gross infection (for example, when a carcass has been carelessly dealt with on a pasture) it is advisable to inject them immediately with serum, and remove them to another field.

Farmers invited to assist Public Authorities.—Stockowners are earnestly invited to co-operate with the public authorities,

(*a*) By reporting to the Police every case of sudden and unexplained illness or death, especially amongst cattle;

(*b*) By isolating an ailing animal, and by protecting any suspected carcass from persons or animals, pending the arrival of the veterinary surgeon employed by the Local Authority;

(*c*) By giving every facility to the officers of the public authorities in carrying out the precautionary measures enjoined by the Anthrax Order; and

(*d*) By affording such officers every assistance in tracing the origin of the outbreak.

They are further strongly recommended to give positive orders to their servants that *under no circumstances is an ailing beast to be killed by them, or its carcass opened, where the cause of sickness or death is unexplained.*

The Ministry has prepared a short notice (A364/T.A.) dealing with the principal points above set out, suitable for posting up in byres or sheds. Copies can be obtained gratis and post free on application to the Ministry.

BLACKQUARTER, QUARTER ILL, OR BLACK LEG

Blackquarter is a bacterial disease caused by the blackquarter bacillus, which, as it can maintain its existence in the soil apart from a living animal body, is called a " soil " organism. The bacillus forms spores, and in this resting stage resists great variations of temperature and retains its activity for long periods.

Distribution.—Although blackquarter is known to have occurred in many parts of Great Britain for a great many years, no statistics of the number of animals that become affected annually, or of the districts in which the disease is prevalent, are available, as it has not been scheduled under the Diseases of Animals Act. The disease appears to be very irregularly distributed, and, even on the same farm, it may occur in some fields and not in others. The danger of infection is greatest on permanent pasture and on uncultivated land, and often disappears when the land is drained and cultivated. Although low-lying, damp land is more favourable to it, the disease is also

found on high land. The disease is usually prevalent in the early spring and summer, but also occurs to a smaller extent at other times of the year.

Animals that contract the Disease.—For all practical purposes cattle and sheep are the only farm animals that become affected in Great Britain. Cases have been recorded of horses and swine dying from black-quarter, but these can be disregarded.

In this country cattle are the principal sufferers from the disease, the mortality ranging from 2 to 20 per cent. of the young cattle on infected farms. There are, however, certain districts in which great numbers of sheep are attacked, notably Romney Marsh, where death-rates of from 2 to 40 per cent. have occurred on particular farms in certain seasons. In the case of Romney Marsh, this high mortality in sheep is probably due not to any peculiar character of the bacillus found in the locality, but to the custom of grazing sheep during the spring and summer to the exclusion of cattle.

Cattle usually become affected between the ages of 6 and 18 months. Although calves under six months are susceptible they seldom contract the disease. Cattle above two years are rarely affected, and it may be said that they become less susceptible with advancing age.

Infective Material and Method of Infection.—The spores may remain active in the soil for years, and their number may be added to by material from new cases, especially if infected carcasses have been cut up on the pastures. The flesh or fluid of the swellings contains highly infective material, as also do the blood-stained discharges. Animals do not infect each other directly, but pick up infection from the soil either by swallowing infected food or by contaminating a wound.

Symptoms.—The period of incubation is usually about three days, but in some cases it may be five.

In *cattle* the earlier symptoms are sometimes not characteristic, and diagnosis is difficult, but, as the disease progresses, distinctive symptoms appear, and, in districts where it is prevalent, most farmers recognize them.

In the early stages, the symptoms are dullness, cessation of rumination, loss of appetite, high temperature, harsh and staring coat, trembling, and coldness of the legs, feet and horns. Later, stiffness, lameness, and arching of the back are also noticeable. On closer examination the characteristic black-quarter swelling may be observed under the skin on those parts of the body covered by thick layers of muscle, such as the

upper leg, loin, buttocks, shoulder, chest or neck. The swellings also sometimes affect the tongue, throat, dewlap, genital organs or mammary glands, but are never seen below the knee or the hock, or on the tail. They are at first hot and painful, but rapidly become cold and painless, and in prolonged cases they may even become hard and parchment-like. When the swellings are pressed a crackling noise, due to the formation of gas by the bacilli in the tissues, is heard.

As the disease progresses, more gas is produced in the swellings, respiration becomes hurried, the animal is greatly distressed, and the temperature may rise to a high point. The pulse is rapid and feeble, and tympanitis (hoven) may be present. Dung, which may be blood-stained, is passed involuntarily. Towards the end the animal usually lies motionless, the temperature rapidly falls, and death follows.

The disease usually lasts from 12 to 48 hours, but in some cases it may be prolonged for 4 to 10 days. The swelling is not apparent in every case if it occurs in the more deeply situated muscular tissues. In the absence of the characteristic swelling, colic or digestive disturbance may be the most apparent symptom, or there may be lameness and stiffness.

In *sheep* the course of the disease is not so prolonged as in cattle. Death usually occurs without symptoms of ill-health being noticed. Sometimes a sheep is seen to falter, fall to the ground, and die in a few moments. In some cases, however, symptoms of the disease are displayed for a considerable time before death occurs. The affected sheep stands stiffly with feet together and back arched, champs its jaws, and breathes heavily. Diarrhoea may be present, with blood-stained excreta, and a frothy, blood-stained discharge from the nostrils may be seen.

Swellings on the body may occur as in cattle, but they are not so apparent.

Post-Mortem Appearances.—In *cattle* the carcass is usually very distended with gases, and blood-stained froth may be discharged from the mouth, nostrils, and anus. As a rule the characteristic swelling is also present. When pressed, the swelling emits a crackling sound due to the presence of the gas, and if it is cut, a blood-stained fluid, possessing a typical rancid odour, distinct from the putrid odour given off by a decomposing carcass, exudes from the cut surface. Owing to the formation of gas the muscular tissue appears to be dark red, almost black in colour, and is porous looking. The blood in the vessels clots and generally is normal in appearance. In some cases lesions are absent in the superficial muscular tissues, but they are usually to be found elsewhere in the carcass.

In *sheep* the muscular lesion is the same as in cattle, but it is not so noticeable. It may be found almost anywhere in the carcass, but is usually present in the upper parts of the limbs. On a close examination of the carcass of a sheep that has died of blackquarter it will usually be found that some part of the carcass is swollen; the fleece overlying the swollen portion pulls away easily, and the skin so exposed is of a dark purple colour. The characteristic crackling of gas is heard if the swollen part is pressed, and if the part is cut into, its appearance is identical with that of the cattle lesion. Even in districts where blackquarter is prevalent, stockowners should always bear in mind the possibility that an animal which has died after a short illness, or which has been found dead, may have died of anthrax. If an animal has shown symptoms of blackquarter during life, and the characteristic swelling distended with gas is also present after death, stockowners would be justified in forming the opinion that death was due to blackquarter, but, if these characteristic signs are not present, it is possible the animal may have died of anthrax.

Prevention.—As the spores are capable of living in the soil, the greatest care should be exercised to prevent any addition to the number of bacilli already in the soil. Careless disposal or unnecessary cutting up of the carcass may lead to the release of large numbers of bacilli. An animal that has died from the disease should not be skinned, as the small amount received for the pelt is out of all proportion to the risk of further infecting the farm.

All carcasses should be properly buried or burnt, especially in the season of castrating and docking.

Several methods of inoculating young stock to protect them against the disease are in use in different parts of the world. Arloing's method consists of two injections of vaccines at an interval of ten days, and it gives the inoculated animal immunity against the disease for about one year. Unfortunately, fatal accidents may follow the operation. The deaths do not amount to much—under 1 per cent. if reckoned on a large number of animals—but, since many deaths may occur on one farm, or in the same district, this form of inoculation should not be adopted unless the losses from the disease are annually very high. A safer method of protection is to use a serum together with a dose of pure culture of the bacillus. Recently preparations of cultures of the bacillus have given good results in protecting animals against blackquarter. The preparations do not contain live organisms and therefore

will not produce the disease, but the immunity is not established until about a fortnight after treatment. Before adopting preventive inoculation the owner of an infected farm should consult a veterinary surgeon who can advise him whether the annual losses from the disease make it worth the attendant risks. The choice of the method of vaccination and the age at which the animals should be treated should be left to the veterinary surgeon, who probably knows which method has been the most successful in the district.

Treatment.—No form of medical treatment has been discovered that can be relied on to cure blackquarter. Certain remedies have been widely advertised, but they have all proved valueless. Some success has been claimed in the past for the method of treatment which consists of incising the swellings and dressing the wounds with antiseptics. This method, however, is now seldom adopted, for, if the patient recovers, as it very rarely does, a large area of tissue sloughs, and the convalescent period is in consequence long and expensive to the owner.

EPIZOOTIC ABORTION IN CATTLE, OR SLIPPING CALF

This disease may be defined as a contagious disease affecting chiefly the pregnant womb, and caused by the bacillus of cattle abortion. It usually, though not always, results in the immature calf being slipped.

Animals affected.—The disease is essentially a disease of cattle, but other domesticated animals, such as the mare, the ewe, the goat, and the bitch, can be experimentally infected, and it is probable that they very occasionally contract the disease by natural infection owing to gross carelessness in the disposal of infected material from aborting cows.

The Microbe.—The microbe is a very small bacillus which may assume either an oval or a rod shape. In the discharges, and in material taken from the after-birth of an aborting cow, the microbes are often found in characteristic clumps consisting of many bacilli, and these clumps are so typical in appearance that their presence enables the disease to be diagnosed with great certainty. The bacilli can be stained with any of the aniline dyes.

Virulent Material and Methods of Infection.—The contents of the infected womb, that is to say, the immature calf, its membranes, and the discharge which the microbe has caused to appear on the lining inside the organ, are all infective. The

microbes are also very plentiful in the stomach and intestines of the calf. The milk very often contains the bacilli. The infected animals, however, are most dangerous to others when they begin to discharge the contents of the womb and these discharges soil the food and water supply. The organisms may also be brought in contact with the genital organs of other animals by the latter lying on soiled litter or dipping their tails into the gutter which is so frequently to be found in cow-sheds behind the stalls. The infected material may be carried some distance by dogs and foxes. It may also be carried on the hands and the boots of attendants. If the animal aborts at a very late stage of pregnancy, and the calf is born alive, it may carry infection to another establishment owing to infective material which is in its intestines. It is particularly to be noted that unless the infective material is disinfected it may preserve its power of infecting for several months. The most common and the most important way whereby infective material is carried from one establishment to another is through the agency of affected in-calf cows, and cows which have recently aborted, and are still discharging. The former by slipping calf may infect the new premises. An animal on infected premises may, although infected, calve at full time. Such cows are very dangerous, because they escape suspicion.

As regards the methods of infection, recent inquiry shows that infection of the pregnant womb is readily brought about if infective material be taken in by the mouth, and that this is the most important way in which natural infection takes place. The pregnant animals, therefore, can become infected by eating grass at pasture, or other food stuffs, or by drinking water soiled by the discharge from an infected animal. Infection can also take place owing to infective material gaining entrance to the genital organs, but this method is not of so much importance in practice as infection by way of the mouth.

With regard to the bull as a source of infection, it is possible that if a bull serves a clean cow a very short time after having served an animal which has very recently aborted it may infect the former. Under the ordinary conditions of farming, however, it is seldom that an animal which has aborted goes to the bull for a month or more after the act of abortion. By this time the discharge has usually ceased so that the bull does not run a great risk of becoming contaminated. Moreover, except in cases where a bull is under no responsible supervision and promiscuously serves a large number of cows whose owners have no particular interest in their health, it is comparatively

seldom that the bull will have the opportunity of serving a clean cow immediately after it has served one which has recently aborted. The bull then, cannot be regarded as a carrying agent of the first importance, but admittedly plays a part in the spread of abortion, and infection in this way must be guarded against.

It is to be noted that many animals acquire a considerable degree of resistance to the disease after one attack, but a proportion of them fail, owing to some defect in their system, to acquire this immunity, and may abort more than once.

Symptoms.—No symptoms immediately follow infection, but the disease runs an insidious chronic course, and, given an infected herd, one can never be sure which animal will carry its calf to full time. Some animals may abort a little more than a month after infection, but the majority do not do so until three or four months afterwards. Indeed, an infected animal may sometimes carry its calf practically to full time, and give birth to it alive. When this happens it may usually be concluded that the animal contracted the infection at a late stage of pregnancy. When a cow aborts in the first, second, or even third month of pregnancy, the slipped calf is often expelled completely enclosed in the membranes. At later stages the membranes are frequently retained after the calf has been expelled.

Warning symptoms are more likely to be observed in animals which abort after the third month of pregnancy. These warning symptoms may last one or two days or only a few hours. A discharge from the genital organs precedes the act of abortion, by even as much as one or two days. Usually, however, the discharge does not appear until immediately before the act. The discharge generally lasts for about a month after the act or somewhat less. At first only a little blood-tinged material is observed, but later the discharge is rather typical in appearance, and in the ordinary way is a good aid to diagnosis. Its colour is usually distinctly yellow, but it may be very dark brown. The more fluid parts are like pus, but clotted masses of the material are also frequently thrown out. They can be seen soiling the root of the tail or on the floor behind the animal. The condition of the udder often furnishes a valuable symptom of approaching abortion. The gland becomes somewhat swollen, and the animal is said to be making a bag before time. The gland may even become suddenly and prematurely active when an animal is about to abort in the later stages of pregnancy. The commonest period for abortion is in the sixth or seventh month of pregnancy.

Prevention.—Eradication of abortion from a herd as briefly outlined in the succeeding section should be adopted whenever possible, but if this is found to be impracticable, owners may try to minimize losses by remembering the following facts:—Since abortion is spread chiefly through the agency of cows which have recently aborted and those which are pregnant and infected, it is of great importance, even though the latter have not yet aborted, to keep them away from other pregnant cows.

Although the bull, as recent inquiry shows, cannot be considered of the first importance in spreading abortion, it would be wrong to disregard it altogether as a means of spreading disease. The danger from the bull arises where it promiscuously serves a large number of cows and is not under responsible supervision. When contagious abortion is prevalent among the animals belonging to owners who make use of this class of bull it would be well for those with clean herds not to send their cows to such a bull. In fact, owners of abortion-free herds should not send cows to any bulls on premises where contagious abortion exists. If, however, it is impossible to avoid sending cows to a bull which comes in contact with animals which have aborted, it should be a rule that the genital organs of the male be thoroughly washed with an antiseptic solution (such as corrosive sublimate 1-2,000) some little time before it serves. Similarly, owners of cows which have recently aborted should not send them to a bull which is being used for clean cows.

It has already been mentioned that an infected cow is not very dangerous until it begins to discharge the contents of the uterus, but that the first symptoms of abortion frequently show themselves before the act takes place. On every establishment where breeding cows are kept these warning symptoms should always be carefully looked for, and should they be observed, the animal concerned should be removed immediately to a special shed. The stall and the immediate surroundings should at once be disinfected with a liberal quantity of quicklime or other disinfectant. Should an animal abort before such measures can be taken it should, nevertheless, be removed from the other pregnant animals, and every part of the building with which the discharges have come in contact (these would be mainly the flooring, gutter and stall) should be immediately disinfected. Everything which comes from a cow which has aborted should be destroyed, and everything which has been used for lifting or carrying the material (barrows, spades, forks, &c.) should be thoroughly disinfected. The best way to

destroy the material from an aborting animal is to burn it, but if this cannot be carried out, it should be put in a pit 4 ft. deep and completely covered three or four inches deep with quicklime. After this has been done the lime should be quickly slaked by pouring very hot water into the pit, and immediately the lime has absorbed the water the pit should be filled in with earth, so as to cause the heat from slaking to be retained for some time. When quicklime is used as a disinfectant for material on floors, &c., a large quantity should be employed, not less than four times the bulk of the material upon which it is to act. It should be well mixed with this material, and then slaked with water as hot as possible, the object being to get a sufficient amount of heat developed during the slaking process to destroy the infective material. For general disinfecting purposes (for implements) a 3 per cent. solution of carbolic acid, or a 1 in 2,000 solution of corrosive sublimate, may be usefully employed. Infected litter should be removed from the cowshed, soaked in paraffin and burnt, for if this contaminated material is not disinfected it may drain on to food or litter, or into drinking water.

So long as there is any discharge from the genital organs of an animal which has aborted, the genital passages should be syringed out twice a day with a mild antiseptic solution (3 per cent. solution of carbolic acid or corrosive sublimate 1-2,000, or permanganate of potash 1-1,000), and the flooring behind the animal should be disinfected at least once daily. When the heavy discharge has ceased it is a good plan, in addition to douching the vagina, to insert a pessary of cocoa butter and corrosive sublimate, 1-2,000, well up the passage twice weekly for two weeks. A cow after aborting seldom discharges for more than a month. Such an animal should not be brought in contact with any pregnant females until the discharge has ceased, and it is advisable to keep the animal isolated for a period of two months. It must be remembered also that a discharging animal should not be isolated on a pasture or in contact with a water supply, because the discharges can infect the grass and water, and, as has already been pointed out, the infective material may retain its activity for months, and so be infective. When the isolation period is completed, it is advisable to wash at least the hind half of the animal with soap and water followed by a disinfecting solution such as a 1 in 2,000 solution of corrosive sublimate before putting the cow back amongst its fellows. It is advisable to kill or isolate for at least two months a calf which has been aborted alive. It may

then be put with clean uninfected calves, but should not be allowed to associate with mature heifers.

No animal which has aborted should be sent to market or sold to another establishment until it has undergone the proper period of isolation, and been disinfected, otherwise it may carry infection elsewhere. With some farmers it is customary to get rid of animals which have aborted. It should be particularly noted, however, that most animals which have suffered from an attack of the disease are usually more resistant to it than those which have not, and that, by keeping animals which have aborted, one may be better enabled to get rid of recurring losses in infected herds, as immunized stock is much more useful for this purpose than new animals. In infected herds it is bad policy to dispose of good milkers or otherwise valuable cows simply because they have aborted, and it is erroneous to imagine that infection can be got rid of in this way, unless one is prepared to adopt in a suitable case the policy of eradication by isolation. On the contrary, to sell off aborted animals one by one and to bring in new ones to replace them, is simply adding fresh fuel to the fire in place of material which in most cases has burnt itself out. It is common experience that after abortion has run through a herd, say, in about three to four years, the subsequent losses are confined almost entirely to the new animals brought in, and the heifers reaching maturity. It is also a common experience that the chief losses may occur in second calvers, that is to say, in those animals which pass the period of pregnancy for the first time inside the byres where infection is established.

Eradication.—In herds which are infected, as shown by the agglutination blood test, but in which abortions are not at the moment widespread or rapidly progressive, or where the infection is slight, the policy of eradication by isolation should be commenced at once, as it is impossible to foretell when the disease will again suddenly become active.

An agglutination blood test of the whole herd should be resorted to, and if the number of affected animals is very small it is well to dispose of them at once.

In other cases the affected and non-infected animals should be divided into two herds and kept on separate premises and separate pastures. The calves from the affected herd may be transferred to the clean herd at the end of two months, and in this way the clean herd may be built up. Any cow brought in should be isolated until the agglutination blood test has proved to be negative.

Vaccine Treatment.—This method should not be adopted unless infection in the herd is widespread and rapidly progressive, and unless isolation of the infected animals would be impossible and useless. In such cases immunization of maiden heifers and empty cows may be carried out by giving them an attack of the disease by the use of vaccine at a safe period (i.e. when empty), in place of allowing them to contract the disease in the natural way when pregnant and so aborting. Although vaccine treatment minimizes the number of abortions in a badly infected herd, isolated cases may occur even after its use. The Ministry is prepared to issue vaccine for use in badly infected herds under certain conditions, and also to advise generally on the methods of control in infected herds. Applications for information should give all the details of the herd, including if possible the total stock, number of abortions per annum, condition of farm premises, and any other details which will be of assistance in forming an opinion, and should be addressed to "The Director, Ministry of Agriculture and Fisheries Veterinary Laboratory, New Haw, Weybridge, Surrey." Postage must be prepaid.

NOTE.—Under the Epizootic Abortion Order of 1922, a cow or heifer which has aborted within the preceding two months may not be exposed in a market, neither may such an animal be sold without previously notifying the purchaser of the fact, or sent for service without notifying the owner of the bull, or turned out on common or unfenced land, or grazed on a highway or on land on which there are cattle belonging to other owners.

FLUKE, OR LIVER ROT IN SHEEP

FIG. 1.

a. Adult Liver Fluke. *b.* Water Snail (*Limnæa truncatula*). Nat. size.

The disease in sheep known as Rot, Liver Fluke, Coathe and Bane has existed in Great Britain for very many years and has been the cause of great losses. Every year a number of sheep

die from the effects of this disease, but in certain years the disease assumes the characters of a widespread epizootic, and the loss becomes enormous. A severe outbreak of this kind occurred in 1879, and continued into the winter of 1880-1. Statistics show that during the period 1879-81 there was a decrease in the number of sheep in Great Britain of no less than three and a half millions. This decrease was reported to be due mainly to the prevalence of Liver Rot. Another severe outbreak occurred in 1920 and is referred to later (p. 30).

Life History.—The common liver fluke is found in the biliary passages of the liver of the sheep where it produces thousands of eggs. These find their way into the intestines and are expelled with the dung. Eggs which fall into suitable surroundings, where there is plenty of moisture and sufficient air, hatch in the course of a few weeks, and liberate minute embryos capable of swimming in water. Dryness is not favourable to the hatching of eggs, but if they are trampled into mud, or fall into surroundings which are not too dry, they may remain dormant for a year or even longer, and continue their development when the environment becomes more suitable. Absolute dryness or hard frost will kill them. On hatching, the embryos swim about in the surrounding water, which may be in a pond or ditch, or may simply be rain or dew on the grass, or the thin film of water on wet ground. Should they meet with a certain water snail, within a period of twelve hours, they bore into the snail's body, and there multiply. If, however, the snail is not found, the embryos die, as they are not able to find food in any other way. After a certain period of time has elapsed the progeny (which may number upwards of one hundred) of each of these organisms leave the body of the snail and again swim in the water, finally coming to rest upon blades of grass or other objects and enveloping themselves in a cement-like material. They now become quiescent and in moist surroundings may remain alive for some months. Extreme dryness and direct exposure to bright sunlight are, however, unfavourable to them. They are just visible to the naked eye as tiny whitish spots on the grass blades. When these quiescent parasites are swallowed with the herbage by a sheep, the little parasite is liberated from the cement-like case, and bores its way, either into the blood vessels of the gut wall, to be carried with the blood to the liver, or, missing the blood vessels, bores through the gut into the body cavity of the sheep, and may wander about there for several days before reaching the liver, where it comes to rest and grows into the mature Fluke (Fig 1*a*).

The period of time between the swallowing of the minute stage which occurs on the grass, and the appearance of the eggs of the fluke in the sheep's droppings, varies between ten and fourteen weeks, eleven weeks being most usual. It has been calculated that an adult fluke will lay from seventy to eighty thousand eggs during a season, some of which are certain to find access to the particular water snail, if any are at hand, and thus provision is made for the life cycle of the parasite.

The snail in question is a small brown-shelled fresh water snail varying in length from $\frac{1}{8}$th to $\frac{1}{2}$ inch. A life-sized illustration of a specimen of average size is given (Fig 1*b*). This snail lives in stagnant water, lying on the mud at the bottom, but also ventures on to the surrounding moist earth, and can thrive in wet places in the absence of standing water. It is usually to be found in low-lying districts where there is a clay sub-soil and where there are no peaty acids in the water. Although most are distributed on low-lying pastures, the snail may occur at higher levels where the sub-soil is suitable and the conformation of the surface is such that sluggish streams or pools of stagnant water may be found. The snail avoids swiftly running water and seeks the dead water underneath the banks of slowly running ditches. It may live in shallow stagnant pools or in marshy places where water usually lies for several months in the year. On large tracts of marshy land the snail is frequently more or less abundant. On pasture of this nature it may be particularly prevalent at those points where the land is much broken by the spoor of sheep or cattle, for example, in the neighbourhood of gates by which cattle enter pastures. In short, in certain districts the snail may be more or less confined to slow-running dykes and stagnant water, whereas in marshy places it may be distributed over the whole of the area. The snail usually breeds twice during the spring and summer months, hatching the first brood in March and the second in July. It is chiefly during the autumn and winter months from September to February or March that the snails give off the parasites which attack the sheep.

Symptoms.—Moderately heavy infestation with these parasites produces symptoms which are well known and almost invariably recognized by farmers and shepherds. In a fluke infested district an animal usually does exceedingly well in the early stages owing possibly to the increased activity of the liver brought about by the irritation which the entry of the first few parasites produces. Later the animal begins to fall off in condition, and its gums and eyes are pallid. The appetite becomes

capricious and the animal progressively weaker. Dropsical swellings appear under the jaws and between the forelegs, and the animal becomes pot-bellied. The sheep refuses to rise on the approach of the dog, and when driven breathes rapidly, usually falling after a short distance and refusing to move. If a post-mortem examination be made of an animal in this stage of the disease the liver will be found to be in that condition known to butchers as " a pipey liver." The bile ducts are thickened and gritty, while the surface of the liver is uneven and often studded with large nodules. Large flukes may be found in the bile ducts and gall bladder, and the bile is usually a dirty chocolate-brown colour.

This is the disease as it generally occurs and as it is commonly recognized by sheep-owners. From time to time, however, outbreaks of a different and vastly more serious nature occur. The last severe outbreak prior to 1920 was that of 1879, which is mentioned on p. 28. A similar outbreak was experienced during the winter 1920-21, although the disease was less widely distributed. As a result of inquiries by the Ministry at this period, it was estimated that in four counties in North Wales alone no fewer than 60,000 sheep died or were killed. There is no doubt that a certain combination of weather conditions is the factor which determines these occasional outbreaks of a severe nature. A mild winter such as that of 1919-20 ensures that a great proportion of the fluke eggs which have been passed out on to the pasture will survive; and, when such a winter is followed by an exceedingly wet summer such as the summer of 1920, the deaths amongst the snails during the two hatching periods are much fewer than in ordinary seasons, and therefore the snails necessary for the development of the young flukes are exceedingly numerous. In these circumstances, a sheep may pick up such a large number of parasites in a few days, as to bring about the death of the animal with such rapidity that the disease becomes almost unrecognizable as the ordinary liver-rot of sheep. The animals may swallow so many flukes within a very short period that death is caused before any of the flukes have reached a quarter of an inch in length. On post-mortem examination of such a case the liver is found to be black, soft, and often putrid, while in the body cavity there is usually a large amount of blood-stained or straw-coloured fluid. This fluid is in reality blood which has escaped from the wounds made in the surface of the liver by the young flukes in penetrating it. Although very numerous, the flukes are frequently so small as to be overlooked by an ordinary observer. Liver rot

is essentially a disease of the autumn and winter, at least it is at this time that infection of the sheep with the young parasites takes place. The infection usually commences in the autumn, and animals may continue to pick up parasites throughout the winter. Taking September as the commencement of the fluke season, the earlier the appearance of symptoms in the sheep the more serious the outbreak of fluke, since the early appearance of symptoms means that sheep are picking up parasites in large numbers. Where the symptoms do not appear until January, February, or March, the inference is that the animals have been more gradually infected. Post-mortem examination will show in the former case that the parasites are all small and that there is an enormous quantity of fluid in the body cavity, whereas in the latter case the flukes are large and adult, and little or no fluid is present.

Distribution.—The distribution of liver fluke follows the distribution of the snail (*Limnœa truncatula*). As a general rule it is confined to lowlands, valleys, and marshes, but it may occur in highlands where the conformation favours the distribution of the snail. Contrary to popular belief, liver rot may occur on salt marshes.

Much more damage is done to sheep than to any other farm animal, but severe losses may also occur in goats and cattle, while rabbits are frequently infected. These alternative carriers of the disease may, in some circumstances, be responsible for perpetuating the infectivity of a pasture which would otherwise have died out.

Prevention.—The obvious preventive is the destruction of the snail which acts as intermediary host. Where practicable this should be done by draining the land. Dykes should be thoroughly cleaned out and provided with an adequate fall to ensure rapid flow. When overhauled, particular attention should be paid to the sheer cutting of the sides of the dykes with the object of doing away with the dead water underneath the banks. These measures are calculated to eliminate dead water in which the snail is commonly found. Efficient drains should be constructed in land that is subject to inundation. The mud weeds, &c., taken from ditches, pools or ponds, when these are being cleaned out, should be treated with copper sulphate (bluestone) either by spraying with a one per cent. solution or covering with powdered copper sulphate.

Destruction of Snails by Chemical Treatment.—Where it is impossible to drain areas efficiently the land may be dressed with copper sulphate by one of the three methods given

below. The copper sulphate should be of the pure variety, containing, roughly, 98 per cent. of sulphate of copper, and for preference should be in powdered form. The best results may be obtained by applying the dressing when the ground and herbage are wet, but not during rain, or when heavy rain is likely to fall immediately afterwards. If done as advised the dressing will find its way into many places which would otherwise be missed, and fewer snails will escape its action.

The choice of one or other of the three methods will be governed by the nature and extent of the area to be treated.

Method 1.—Spraying with a solution of copper sulphate by means of a charlock sprayer, or one of the " knapsack " type of sprayers used in horticulture.

Where possible soft water should be used to dissolve the bluestone, as it tends to precipitate in hard water. The strength of the solution to be used depends upon the type of ground and vegetation. If the land is comparatively dry and much herbage is present, it is better to use a $\frac{1}{2}$ per cent. solution, and apply up to 137 gallons to the acre. On waterlogged or partially flooded ground, up to a 2 per cent. solution may be used in amounts of 80 gallons to the acre.

At the time of spraying the land, the pools, ditches, and patches of stagnant water should be treated by the addition of sufficient copper sulphate to make a dilution of one part of copper sulphate to one hundred thousand parts of water. For example, if measurements indicate that the contents of a pond are roughly 100,000 gallons, then 10 lb. of copper sulphate should be added to make the requisite dilution. This can conveniently be done either by suspending the necessary amount of bluestone in a piece of sacking which is moved about the pond or ditch, or by adding the necessary amount of chemical to the water in the form of a concentrated solution. The best period of year to apply the copper sulphate is after the second breeding season, that is, between the later part of July, and September, to enable it to attack the adult snails, since the solution does not appear to be injurious to the eggs of the snail. It should be pointed out that it is unnecessary and undesirable to treat ordinary clear fast running streams with copper sulphate, since the snail is not found in such streams and the solution of copper sulphate will kill trout and other fish.

Method 2.—The application, by dusting, of a mixture consisting of one part by weight of finely ground copper sulphate and four parts by weight of china clay (kaolin). This

method is useful for small areas, narrow ditches, pond edges, etc., and can be applied by means of a hand dusting machine, or other dusting apparatus.

Method 3.—Broadcasting. This is probably the best and easiest method for the treatment of large areas of wet land. The mixture consists of one part of finely ground copper sulphate, with not less than four parts (up to eight parts may be used) of *dry* sand. This mixture should be applied as evenly as possible. The amount required per acre is 28 lb. of copper sulphate and from 1 to 2 cwt. of sand, i.e., from $1\frac{1}{4}$ to $2\frac{1}{4}$ cwt. per acre, total weights.

N.B.—Stock should not have access to land treated by any of the above methods until after a good shower of rain.

Avoidance of Wet Pastures in Winter.—Where some portions of a farm are marshy and infested with flukes and other parts are well drained and sound, the farmer would be well advised to use the marshy pastures only in the dry summer months, while some types of ground may be rendered safe by fencing off small moist danger zones, which are suspected or known to be inhabited by the snails. These are practices which have enabled many farmers to carry on and to get the best out of farms, which consist partly of badly drained land, without incurring the expense of draining.

Natural Enemies.—The snail has certain natural enemies notably the duck, (both wild and domesticated), plover, wagtails and frogs. These will assist in keeping down the number of snails, and should be encouraged.

Control of Alternative Carriers of Disease.—Rabbits should be exterminated on fluky ground, as, being possible carriers of the liver fluke, they keep the infection alive, and hinder the efforts that may be made to exterminate it. Goats may be treated as sheep. Cattle are liable to become infected, and suffer in consequence more frequently than is generally supposed: it is not safe to place them on infected pastures in the autumn and winter months. Treatment of cattle is unsatisfactory, as they are particularly susceptible to carbon tetrachloride poisoning, and although male fern extract sometimes gives good results, it is unreliable and too expensive for general use.

Treatment of Infected Sheep.—Apart from prevention, liver fluke can be cured by treatment, but the attention of a qualified veterinary surgeon is usually desirable in such cases.

Experiments with an extract of male fern have shown that this preparation is very efficacious for the treatment of

ordinary cases of liver rot. It is necessary, however, to weigh the individual sheep in order to calculate the dose, since a slight deviation from the standard employed is sufficient to destroy the value of the treatment. Too large a dose may kill an animal, whilst, on the other hand, too small a dose may fail to remove all the flukes. The treatment is simple in that it involves only two doses which are given on successive days. It is desirable that the animals should be fasted for 12 hours prior to each dose of the drug. Experiments carried out with this preparation have shown it to possess a very high efficacy, all the flukes being removed by the two doses in the cases on which it was tried. Infected animals should be moved to higher pastures where the snail is not likely to be plentiful, and where the life-cycle of the fluke would thus be broken. Where it is the practice to winter sheep on lowlands, bringing them down from the higher land in September or October, it is an excellent plan if the pastures are known to be fluke infested to treat the sheep twice during the course of the season. The first treatment should be given in from two to three weeks after the sheep have been placed on the suspected pastures, and should consist of the usual two doses of male fern extract. A second treatment may be given about the end of December.

Another drug which has proved highly effective for the treatment of cases of liver fluke is pure carbon tetrachloride. The cost per head is smaller than in the case of male fern extract, and only one dose is necessary. This treatment consists of a single dose of 1 c.c. of pure carbon tetrachloride administered in a soft gelatine capsule. No previous preparation of sheep is necessary.

Since the dosage destroys only mature flukes, or those approaching maturity, it is necessary to repeat the treatment after a period of about four weeks.

When some individual sheep show symptoms of liver fluke infection it indicates that many more, and perhaps all the members of the flock, are carrying the disease. Mass treatment of the whole flock is, therefore, the proper course to follow.

Where liver rot frequently appears, it is wise to dose every sheep once a month, commencing at the beginning of October and ending early in April, while flocks on less dangerous ground may be dosed in December and again in March.

It must be pointed out, however, that deaths have been recorded following the use of the carbon tetrachloride treatment, particularly in flocks receiving artificial foods, or folded

on arable land. These deaths are not due to over-dosing, since in the ordinary way sheep will stand a dose of 20 c.c. or more without any bad results. The poisoning is thought to be due to some deficiency in the food, which renders the sheep unable to tolerate the smallest dose of the drug. In view of these losses, therefore, it is advisable to dose only a few representative members of the flock, in the first instance, particularly if the sheep are not on free range, and to be guided by the effect of the dosage on these before proceeding with the treatment of the whole flock.

To summarize, the preventive and remedial measures which should be taken against liver fluke in the order of their respective importance are as follows:—(1) Drainage; the effects of drainage are permanent. (2) Dressing the land, and treating the water of ditches, ponds, &c., with copper sulphate to destroy the snail. (3) The keeping of sheep on good, well-drained land during the autumn and winter months when fluke is likely to be contracted. (4) The curative treatment of infected sheep with male fern extract, or carbon tetrachloride.

FOOT-AND-MOUTH DISEASE

Foot-and-mouth disease is caused by a virus which is too small to be seen even by the aid of the highest powers of the miscroscope, and it can pass through the minute pores of bacterial filters. Such a virus is spoken of as " filterable."

Animals Subject to the Disease.—Practically all the domestic animals and wild ruminants can be infected with foot-and-mouth disease. This statement, however, requires a certain amount of qualification. Cattle are usually looked upon as more susceptible to the disease than sheep, pigs, and goats, but the experience in Great Britain during the last few years has been that, given an outbreak amongst pigs or sheep, the disease spreads as rapidly as in the case of cattle. Human beings may also contract foot-and-mouth disease, though they are not in the most susceptible class.

The degree of susceptibility varies considerably, even amongst susceptible animals, and it has not infrequently been observed that certain animals appeared to resist infection when their fellows were suffering from the disease.

Symptoms.—As the owner and attendants are often the only persons in a position to suspect the existence of disease in the first instance, the symptoms are described here to enable them to be on their guard against it, but not with the object of encouraging them to attempt to distinguish between foot-

and-mouth disease and other diseases with somewhat similar symptoms. Foot-and-mouth disease is so serious to stock-owners in general, that, if there is the least suspicion of its presence, that suspicion should be reported immediately to the authorities. (See section on *Reporting the Existence or Suspected Existence of the Disease,* p. 40.)

The incubation period after natural infection is from 48-72 hours to ten days, but the shorter periods are the more usual.

The chief symptoms of the disease are common to all affected animals, although the effects of the virus vary somewhat. In the initial stage the animals are dull, off their food, and if their temperature is taken, it will be found to be higher than normal—105° F. or even higher in cattle. At this stage, however, it is unlikely that a farmer would suspect the existence of foot-and-mouth disease.

The first symptoms of the disease to attract the farmer's attention are the sudden appearance of lameness, or slavering at the mouth, or both. Lameness in a number of animals, especially if present in more than one species—cattle and pigs or sheep for example—should arouse the gravest suspicion. Salivation (slavering) in a number of animals or even in one animal should always be looked upon with suspicion, and should lead to an examination of the mouth. In affected cattle, salivation is very frequently accompanied by a smacking or sucking sound, which is a very characteristic symptom of the disease. Slavering, however, is not nearly so noticeable in pigs and sheep as in cattle, and it is usually sudden lameness which first attracts attention in the first two. It is to be noted, also, that the lameness might escape the casual observer, as the animals are often so foot-sore that they remain lying down. Cattle, however, when moving frequently shake their feet, as if trying to remove something from a hoof. Sheep, of course, will usually rise and move away when approached; if not, it probably means that their feet are very tender.

The lesions of the disease consist of vesicles (blisters) which appear on the mucous membrane, especially that of the mouth, and on the finer parts of the skin. In the mouth they appear on the pad, on the inside of the lips, and on the tongue. About the feet they are usually found around the coronet, at the junction of the skin with the hoof, at the base of the supernumerary digits, and on the soft tissue between the clays. They are also commonly found on the teats in females. Less commonly they may be seen round the muzzle, inside the vagina, and, in pigs, on the skin of the body. The vesicles

vary in size and shape; quite commonly they are an inch in length, but they may be much smaller. They are easily broken by handling. When broken, a clear liquid flows out, the mucous membrane over the vesicle looks ragged, and the under surface has a very red or raw appearance, which afterwards becomes yellow. On parts like the pad, where the mucous membrane is dense the affected part of the mucous membrane may be much thickened, and may remain attached after the vesicle is broken. On being handled this thickened portion of membrane comes away in the form of leathery-looking tissue leaving a raw surface. About the feet the vesicles are similar to those in the mouth, except that the covering is denser. Cattle at pasture often show rapid loss of condition when attacked, as, owing to the pain in their mouths and feet, they are unable to obtain sufficient nourishment. In milch cows the milk yield falls considerably, and when the teats are affected, injury of a permanent nature may arise in the udder. The inflammation in the feet may lead to shedding of the horny parts. This happens in the later stages of the disease, but more commonly in sheep and pigs than in cattle. Even in the earlier stages the horn can frequently be seen separating around the coronet in a downward direction in sheep and pigs. Very young calves may die from enteritis (inflammation of the bowel) without showing external eruptions.

Animals usually recover from foot-and-mouth disease, but the loss, owing to depreciation, loss of milk, or permanent injury, is considerable. Some outbreaks, however, are more virulent than others, and in a very virulent outbreak a considerable number of animals may die.

Infection.—The contents of the vesicles are infective, and therefore material contaminated thereby (such as saliva, hides, foodstuffs, litter, dung and milk) will also be infective.

Infection is spread from animal to animal by the fact of the animals being together in buildings or on the pastures, or by the hands of milkers, or by the hands, boots or clothes of other attendants. It may be carried considerable distances on foodstuffs, and through a water supply being contaminated. When an animal is salivating, the threads of saliva and straws contaminated thereby may be blown a considerable distance by the wind, and thus reach other animals, or a watercourse from which they drink. The roads along which affected animals have passed, and the wagons in which they have travelled, may remain infective for some time. Rats, fowls, birds, cats, horses and dogs may act as mechanical carriers of

infection. It is also conceivable that human beings affected with the disease might convey it to animals. The spread of infection from place to place is most insidious. Much evidence has been collected which goes to show that a human being may, through his clothes, make the clothes of others infective. There is also a considerable amount of evidence that some animals which have recovered from the disease may be infective to others for a considerable time after recovery. The virus enters the body through the mucous membranes, and probably the commonest method of infection is by way of the alimentary tract. A very small amount of the material from the vesicles has been found sufficient to cause infection.

Although the virus is destroyed by heat, sunlight or disinfectants, it may, under certain conditions, remain active for long periods in the carcasses of diseased animals and on contaminated material.

Prevention.—It is not intended under this heading to deal with prevention in the sense of administering so-called preventive drugs, or resorting to preventive inoculation. There is no drug known which renders an animal resistant to foot-and-mouth disease, and science has not so far provided a practicable method which can be used to immunize animals artificially.

If the disease breaks out on any premises it is the duty of the owner to take all reasonable measures to prevent the affected or suspected animals, and those in immediate association with them, from coming in contact with those of his neighbours. Affected stock should be kept away from a public road, from a water supply which reaches other farms, and from boundary fences immediately beyond which other stock are pastured. The attendants should be warned not to go amongst other cattle, sheep, goats, or pigs, and all persons who have to leave the premises should disinfect their boots before doing so, otherwise they may carry infective material on to the roads or elsewhere. The boots should be scraped to remove particles of manure, and afterwards they should be swabbed with an ordinary disinfecting solution. If such is not available a saturated solution of common salt in hot water may be used. Milk should not be allowed to leave the premises, nor should it be given to other animals on the premises, unless it has been previously boiled. Dogs and poultry should not be allowed to roam at large.

FIG. 2.—Feet of a pig affected with foot-and-mouth disease. The vesicles have ruptured and the horn is separating.

Fig. 3.—Portion of the tongue of an ox, showing early lesions of foot-and-mouth disease. The tip of the tongue shows a recently ruptured vesicle, while further back an unruptured vesicle is seen.

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FIG. 4.—Tongue of an ox affected with foot-and-mouth disease, showing two recently ruptured vesicles and a considerable amount of scaling of the epithelial covering at other parts.

The above precautions apply mainly to the owners of infected premises and any persons for whom they are responsible. It may happen, however, that other owners or their employees may find themselves on suspected premises before an outbreak has been declared. In such circumstances they should carry out the above-mentioned measures of disinfection, and they should refrain from attending to other animals until they have further disinfected their hands, and changed their boots and clothes.

Precautions to be taken at All Times.

1. *Precautions regarding Foodstuffs:*—(*a*) Scraps of meat or any other part of a carcass of an animal, or any broken or waste foodstuffs including table or kitchen refuse which contain or have been in contact with any meat or other part of a carcass of an animal, *must not, until they have been thoroughly boiled for at least one hour, be brought into contact with, or fed to, pigs or other animals;* and no animal must be permitted to be brought into contact with such meat scraps or other foodstuffs until these have been so boiled. In this connexion it should be borne in mind that "green" bone meal, i.e., non-sterilized ground bones, is commonly fed to poultry. This preparation is a potential source of infection and care should be taken that animals are not permitted to have access to the meal.

(*b*) It is a wise precaution to sterilize, disinfect, or destroy any sacks in which any such meal or other animal foodstuff is obtained, when the food has been removed therefrom.

2. *Packing cloths, wrappers, boxes, etc.,* which have been used for the packing or carriage of meat or other animal products *must not* be allowed to come into contact with any animal, unless and until they have been boiled or otherwise thoroughly sterilized after being so used.

3. *Hay or straw* which has been *used for packing merchandise must not* be used as bedding or allowed to come into contact in any other way with animals. It must not in any case be removed from the premises except used as packing; or for destruction or for return to the senders in a crate or box for further use as packing. If not used again as packing it must be destroyed.

4. *Tree, shrubs,* plants, bulbs, &c., packed in hay or straw *must not* be taken into any market or saleyard where animals are exposed for sale.

Warning.—The directions contained in the above paragraphs 1 (*a*), 2, 3, and 4 are imposed by Order of the Ministry under

the Diseases of Animals Acts, and failure to observe them is punishable by fine and imprisonment.

Reporting the Existence (or Suspected Existence) of the Disease.—The attention of stockowners is directed to Section 4 of the Diseases of Animals Act, 1894, and Article 1 of the Foot-and-Mouth Disease Order of 1928, which in effect provide that every person having or having had in his possession or under his charge an animal affected with or suspected of foot-and-mouth disease shall with all practical speed give notice to a police constable.

The object of immediately reporting any suspicious case is to enable the authorities to have immediate inquiry made and, if disease is found to exist, to isolate it, and stamp it out before it can extend throughout the country. As the result of the disease spreading in 1869, it persisted in Great Britain until 1872, and it is estimated that 3,000,000 animals were attacked. An estimate was made of the losses sustained from the disease between 1870 and 1877 in Northumberland and Westmorland alone; in that period there were 9,035 outbreaks in these two counties, 236,755 animals were involved, and the loss was about £300,000.

The disease spread again in 1881-1884. In Great Britain 26,484 outbreaks occurred and 710,362 animals became affected, of which 9,361 died and 5,874 were slaughtered.

The Departmental Committee that investigated the serious and widespread outbreak of foot-and-mouth disease in 1923-4 reported that the most fruitful cause of the spread of the disease from the primary outbreaks, and the most difficult one to combat, was the indifference of stockowners to the importance of prompt notification, upon which the success of the policy of eradication very largely depends. The only alternative to the policy of eradication would be isolation, which would inflict considerable losses on the individual farmer. For example, a farmer whose herd of 141 cattle was isolated on account of the disease during the above mentioned outbreak stated in evidence before the Committee that his losses, which he set out in detail, amounted to over £2,000.

Figs. 2 and 4 are from the Report of the Departmental Committee on Foot-and-Mouth Disease, 1914. [Cd. 7270.] (London: H.M. Stationery Office, price 4½d.)

FOOT-ROT OF SHEEP

There has been, and still remains, among flockmasters, shepherds and others a good deal of diversity of opinion as to whether foot-rot of sheep ever constitutes a contagious disease

i.e., a disease communicable from a diseased sheep to a healthy sheep, or not.

This difference of opinion appears to be mainly due to the fact that almost any diseased condition affecting the feet of sheep, associated with lameness, is usually classed under the general and ambiguous term foot-rot, and in that way non-contagious affections of the feet of sheep, causing lameness, have supported the view of some observers that foot-rot of sheep is not a contagious disease.

Non-contagious Foot-sore

It is important to recognize that in a flock of sheep several animals may be simultaneously lame from injury to the feet, and the disorder show no tendency to spread through the flock. Such a condition, however, is not true foot-rot, although the injured feet may present ugly sores. It would be better described as foot-sore.

The non-contagious form, or foot-sore, which is due to injury to the foot, has its starting point usually in the horn itself. The horn may be decayed, broken, cut or bruised, and, through the opening in the horn, soil and filth gain an entrance and set up inflammation of the sensitive structures of the foot, from which pus is usually discharged.

Among the conditions which predispose to this form of foot-sore may be mentioned the continual grazing of sheep on low-lying marshy pastures where the grass is long, particularly during prolonged wet seasons, and neglect of attention to trimming the horn, which under such adverse conditions becomes overgrown, gives an uneven treading surface, and is very liable to become soft and even decayed. Injuries may be inflicted by the animal stepping on sharp or rough objects, such as sharp stones, glass, nails, thorns, &c., and by over-trimming of the feet. They may also arise from travelling sheep for long distances on hard roads, or from anything which causes a breach in the horny foot, or bruises the sensitive foot, especially when the horn is worn or thin.

Symptoms.—The non-contagious foot-sore is the commoner condition met with, and it is not unusual to find one or more sheep in a flock affected. Although lameness may not be a marked symptom from the first, yet it is usually the first indication to the shepherd that there is anything the matter with the foot, and by this time in such cases, the lameness denotes that inflammation and suppuration have set in.

It will be observed, with perhaps rare exceptions, that in this non-contagious affection the disease has commenced at or

near the under surface of the foot, and that the destructive process extends from below upwards. If pus forms and remains imprisoned within the horny box it will burrow and work its way towards the softer structures of the coronet as a way of exit, because the softer structures offer the least resistance to its progress. The foot becomes swollen round the coronet; it is hot and tender, and one or more small abscesses may appear on the coronet or heels. These abscesses burst, and discharge thick pus, which is frequently mixed with a little blood. The parts may continue to discharge pus, or they may heal up, but even when the outer wound is apparently healing and is closed by a layer of coagulated exudate on its surface, the pus may again be imprisoned, with the result that abscesses appear at other parts of the coronet. Providing there is an exit for the pus at the lower surface of the foot these secondary abscesses will not occur, since the pus, as it is formed, is continually discharged from the opening, which affords a natural drainage for the matter within the foot. If after the injury an outlet through the horn remains for the escape of pus, the case may recover in a few days without any treatment. On the other hand, if the breach in the foot is too small and does not allow the free escape of the pus, suppuration continues. Granulation tissue and new horny material are formed, and the former grows out from the sensitive parts in the form of what is commonly called proud flesh from which a continual discharge oozes. The sore bleeds easily, and the foot becomes distorted.

Treatment.—By carefully trimming the foot, cleansing the wounds with antiseptics, applying a dressing if necessary, and removing the affected sheep to drier pastures, the flockmaster will enable many cases to recover promptly. In those cases where the injury has been aggravated by extensive suppuration the feet require careful and repeated individual attention. It will be found that although the non-contagious affection is the commoner, it usually affects only a comparatively few animals in a flock, unless they have all been subjected to like conditions. There is no evidence of the spread of contagion from sheep to sheep, and frequently only one foot is affected.

Contagious Foot-Rot

Contagious or true foot-rot of sheep is quite a different form of disease to the foot-sore already described, and in this country stands as one of the most serious diseases that exist among sheep generally, but it is a disease which is amenable

to treatment, and can be prevented. If sheep-owners, therefore, appreciate the contagious nature of the disease and adopt effectual measures to prevent its introduction into a flock, or combat it promptly when introduced, they will be well repaid for their trouble.

Experiments have demonstrated the infective nature of the virus or poison of the disease by the application of the infected matter from diseased sheep to the feet of healthy sheep, and by the association of healthy sheep with diseased animals. The disease may affect sheep on dry or wet pastures if the infective agent be present.

It is admitted by those who are acquainted with the diseases affecting the feet of sheep that in some cases of foot-rot, especially in those well advanced, the diseased conditions may be so similar in appearance to foot-sore, that a differential diagnosis is very difficult; but by carefully considering all the circumstances, and by examining the fellow sheep, especially the more recent cases of disease, one will find that in foot-sore the trouble begins in the horn at the lower part of the foot.

Contagious foot-rot is primarily a disease affecting the soft structures of the foot. Any diseased condition of the horn itself is secondary, and is brought about by the separation of the soft from the horny structures through the agency of micro-organisms and the fluids exuded. The disease spreads from sheep to sheep, causing much lameness, loss of flesh, and even death from emaciation. If the disease appears in a flock of in-lamb ewes it is a still more serious matter, as proper treatment cannot be carried out without danger, owing to the pregnant condition of the ewes. In such instances the disease persists until the lambing season commences, and often spreads rapidly to the new-born lambs.

Apart from the adverse influence that wet seasons and damp low-lying pastures may have upon the horny structures of the feet, grit and dirt may work their way into the cleft of the foot and produce a wound. If the soil is contaminated with the virus that produces foot-rot, the disease will soon appear among the flock. It may, however, attack sheep with apparently firm horn and well trimmed feet.

Symptoms.—Lameness is usually the first symptom observed, and on examination of the affected foot a small, moist, unhealthy looking, spot-like sore will probably be found between the toes. The part is inflamed, hot and tender, and when it is manipulated, the animal shows signs of pain. There is little or no appreciable swelling of the coronet at this stage. The disease

rapidly extends under the horny box, and if a little pressure be brought to bear on the inside of the foot a slight dirty fœtid discharge will be observed oozing from the edge of the horn around the ulcerated spot. The discharge is never very great, but is always foul smelling; in fact the fœtid smell is often detected before any gross lesions have been discovered.

The disease progresses from above downwards, between the sensitive structures of the horn and the hoof. When the horn is pared away the diseased parts are found bathed in the fœtid discharge, and the greater portion of the foot may be involved. In some cases the disease extends from the primary seat of the disease to the more important tissues of the foot, injuring the ligaments, tendons, and even the bones.

In protracted or severe cases the foot may be greatly swollen, very tender, and hot. The upper part of the toe is widely separated and the points turn inward, giving the appearance of a club. The animal is in great pain when weight is placed on the affected limb. Abscesses form in the soft tissues of the foot and burst outwardly around the coronet, leaving angry discharging wounds. One foot is usually affected at the outset, but the disease frequently appears in two, three, or even all four feet. In such a case the animals are unable to move about in search of food. They may be seen feeding on their knees, or lying down feeding on the grass around them. In cases associated with much pain, and where three or four feet are affected, the animals refuse to feed, rapidly lose flesh, and may develop diarrhœa. Such animals become extremely weak. They present a dejected and emaciated appearance, and may die. The various stages of the disease can be seen in one flock. Granulating tissue or proud flesh and new horn-like tissue may grow out from the wounded surfaces. In the early stages of the disease the hoof itself appears normal, but as the condition advances the horn becomes broken and decayed, and if the feet have not been attended to, the whole toe may be cast. During hot weather the condition is aggravated, and deaths are more numerous from the fact that the fœtid discharge attracts flies, and maggots subsequently develop in the wounds. An affected animal may become fly-blown on every part of its fleece which has come in contact with the discharges, and under such conditions it soon succumbs.

Prevention.—It has been said that a shepherd has no right to have foot-rot among his flock. Providing ordinary care is observed the disease should at least not get beyond control. Although the best plan to prevent the introduction of the disease

is to avoid bringing suspected sheep on to clean pastures, it is not one which can always be carried out. Attention must especially be directed to fresh arrivals. In the first place it is necessary to examine any sheep which may fall lame, and any sheep which are not lame but are noticed to show wounds or sores around the hoof or over-grown horn.

1. Periodic inspection, examination and trimming of over-grown feet is a practice to be recommended, and upon the slightest indication of disease affecting the skin between the toes, the affected sheep should be isolated and treated, and the remainder put through a bath containing one of the preparations given below as cures for foot-rot.

2. In the case of sheep bought in a market, or taken to a market and brought back, or any fresh arrivals, they should whenever possible be isolated and the feet of each sheep examined. Isolation should be continued from three to four weeks, as disease might appear after an interval of two or three weeks, although the sheep appeared to be free from disease at the time of arrival; or, as a precautionary measure after examination, the sheep should be put through one of the specially constructed shallow baths containing one of the preparations recommended below, on two or three occasions during the first week or ten days after arrival and before mixing with the other stock.

3. The shepherd should always wash and disinfect his hands after examination of the recently imported stock before attending to any of the old stock, and the same remarks apply after the examination of any individual suspected case.

4. It is advisable to afford contaminated pastures a rest from sheep until a winter's frosts have intervened.

5. Attention must be given to the sheep fold and other pens, which should be thoroughly and effectually disinfected, and the manure and a few inches of the surface soil should be removed and ploughed into the land.

Treatment.—1. In the first place examination of the entire flock and separation of the healthy from the diseased animals should be carried out. The apparently healthy sheep should daily, or every second day, be put through a shallow bath or trough containing some suitable preparation, and the treatment may be advantageously continued for ten to fourteen days after the last case is detected.

2. It has been observed that a sheep may apparently recover from foot-rot without treatment, and the disease may break out again in the same sheep after an interval of several weeks. The

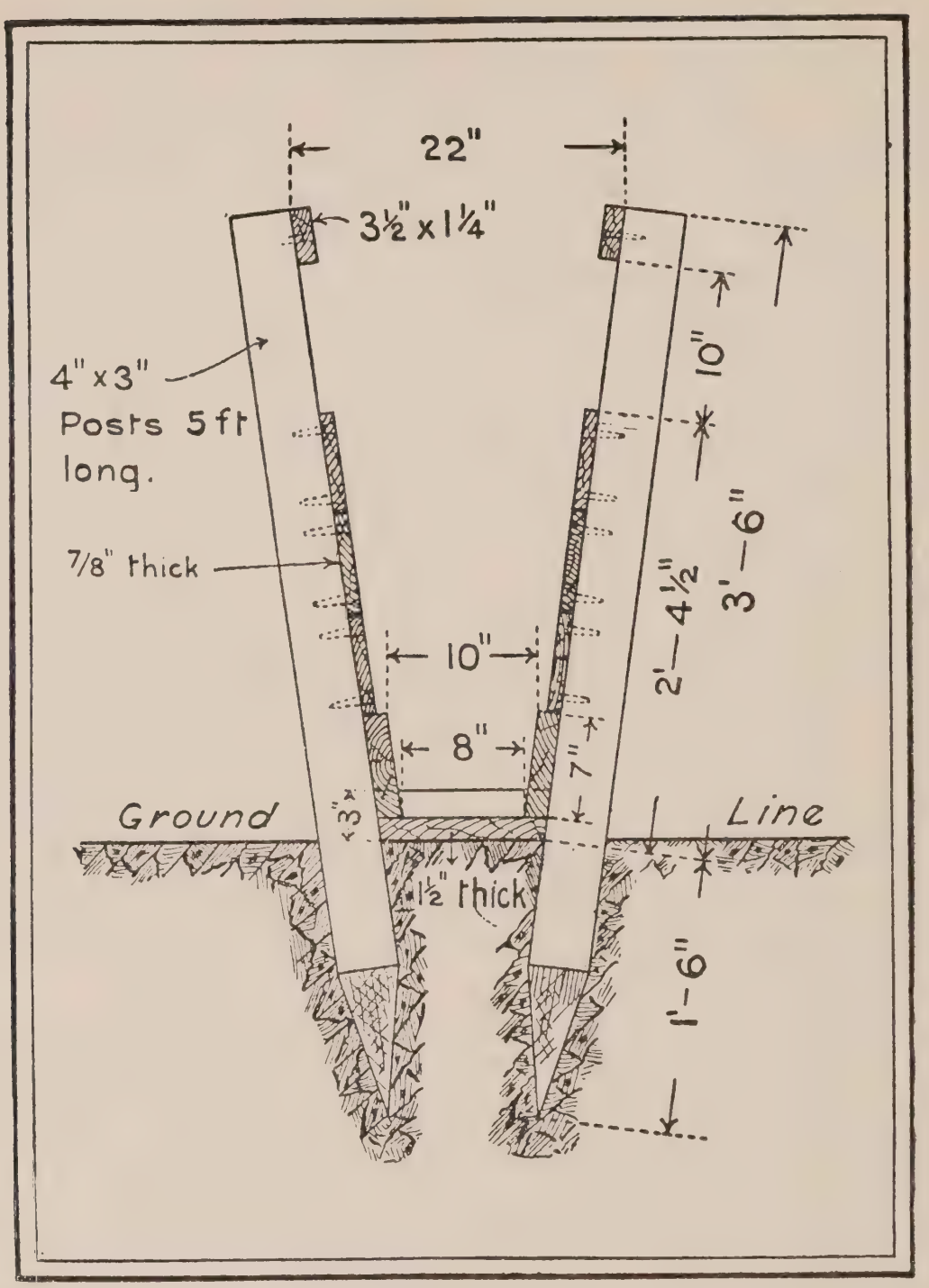

Fig. 5.

Foot-Rot Bath.—The bath, of which this is a vertical cross-section, may be made of wood or concrete, and should be about 16 ft. long. The width at the bottom should be 8 in., the sides about 7 in. high, sloping outwards, and if made of wood, boards about $1\frac{1}{2}$ or $1\frac{1}{4}$ in. thick should be used. The ends should be 3 in. deep, or a little more than shown in the sketch, but deep enough to retain the solution while allowing the sheep to step over them easily. The bottom of the trough, if of wood, should have cross pieces nailed or screwed on at intervals of about a foot to prevent slipping. The floor of a concrete bath should be supplied with transverse grooves.

The sides above the trough should be nailed to posts 4 in. by 3 in. and 5 ft. long, driven firmly into the ground, 4 ft. apart. The run thus made should be wide enough to allow the sheep to walk freely through, and a width of 18 in. at 2 ft. from the ground will be found sufficient even for in-lamb ewes.

second attack may be even worse than the first, but the animal may eventually recover without treatment, or it may die. Treatment, however, is necessary to avoid loss, and prompt measures will materially assist in arresting the spread of the disease to other members of the flock. The earlier the cases are recognized and treated, the more readily and certainly will they yield to treatment, and aggravated and advanced cases—usually the result of neglect—should rarely occur. Everything possible should be done to prevent the disease extending into the deeper structures of the foot, as these cannot be effectively treated without permanent damage to the foot. After thorough cleansing of the affected foot, all detached horn should be freely but carefully removed, so as to expose the affected sensitive surfaces. Skill and patience must be exercised in paring away the horn of the foot, and the operation should not be carried out in the somewhat rough and careless manner that is adopted by some shepherds. It is imperative to expose all the diseased tissue, and the more advanced and neglected the case the greater will be the labour required. The exposed diseased parts should be thoroughly cleansed with suitable remedies by washing, or by standing the sheep in a bath for several minutes. All granulations or fungoid growths should be removed with the knife or snipped off with scissors.

3. It is important to remember that all removed particles of horn or other tissue should be destroyed, buried or disinfected, as such material may serve as a means of further spreading the disease.

4. Whenever the cutting has been deep or the exposed surface is extensive, a piece of clean tow, previously saturated in some antiseptic solution, should be applied, and kept in position by a properly adjusted bandage.

5. Advanced and severe cases, implicating deep structures of the foot, will require more constant attention and repeated treatment, such as cutting away as much of the diseased tissue as possible at each inspection, cleansing and disinfecting, and finally covering the parts with antiseptic powder and bandaging to keep out both soil and filth. In the case of in-lamb ewes every care should be taken in handling the ewes, and when individual treatment is deferred until after lambing, all the flock should in the meanwhile be put through the shallow bath (mentioned below) in the ordinary way at frequent intervals.

The Use of the Foot-bath.—It was noticed some years ago that the ordinary process of dipping sheep had a curative

effect on foot-rot, and the good results were ascribed to the action of the poison on the cause of the disease. Arguing from this it appeared probable that beneficial results would follow the walking of affected sheep through a solution of poison just deep enough to cover the hoof. In practice this was found to be the case.

In order to test the effects of such treatment on a considerable scale the Department, early in 1904, distributed 30 baths (16 ft. by 1 ft.) each accompanied by 1 cwt. of copper sulphate (bluestone), amongst a corresponding number of sheep farmers in Great Britain. The instructions were to walk the sheep once a month or oftener through a 5 per cent. solution of the copper sulphate (1 lb. in 2 gallons of water), after having cleaned and dressed the hoofs in the case of a bad attack.

Reports from most of the recipients were received, and they were quite unanimous in ascribing much benefit to the use of the bath. It would appear, however, from the information to hand, that still better results (especially where it is a case of curing rather than preventing) would be got by using a 10 per cent. solution (1 lb. of copper sulphate to 1 gallon water), and, as stated above, the sheep should be put through the bath at frequent intervals.

The Ministry has experimented with copper sulphate only, although it is realized that other substances are used, e.g., 3 oz. arsenic, mixed with 3 oz. washing soda and boiled in 2 gallons of water; or 1 part of commercial sulphuric acid to 10 parts of water. Arsenical and other sheep-scab dips may also be used, but it is doubtful whether any substance is more effective than copper sulphate, which is comparatively safe and easy to use.

Summary of Directions for using the Foot-bath.—*a*.—Bath of wood or concrete, 16 ft. long and 8 in. wide (12 in. is unnecessarily wide), sides sloping out, ends 3 in. deep, provided with cross pieces or grooves to prevent slipping, side fences close boarded and sloping outwards so as to admit of the sheep walking easily through. (*See* Fig. 5.)

b.—Solution to consist of 1 lb. copper sulphate in 1 gallon of water or, if prevention only is aimed at, half this strength will suffice. Time to be allowed for thorough solution.

c.—Copper sulphate to be brought under a guarantee of purity (98 per cent.), and if possible in the powdered state, not in large crystals.

d.—Sheep if badly affected to have their hoofs pared before being put through the bath.

e.—A day to be selected when the grass and soil are dry.

f.—Copper sulphate and most of the substances used being poisonous, a cover for the bath to prevent stock drinking the solution may be an advantage. In any case the bath must be well fenced in.

g.—If ewes with lambs at foot are treated, they should be put through very quietly so as to prevent the solution getting on to the teats, and thus into the mouths of the lambs.

h.—Sheep with long wool should also be put through very quietly, or otherwise the solution may, under certain circumstances, discolour the wool.

GLANDERS AND FARCY

Definition.—The names glanders and farcy relate to one and the same disease, which is caused by a microbe—*Bacillus mallei*. The term " farcy," however, is usually applied to those cases in which the disease is located on the surface (skin) of the limbs or body, and the term " glanders " is used to describe the disease when the principal symptoms are seen in the nostrils, glands under the jaw, and lungs.

Animals susceptible to the Disease.—Horses, asses and mules are most commonly affected with glanders. The dog, the cat, and the wild carnivorous animals may be infected.

The ox never contracts the disease, while for all practical purposes the sheep, goat and pig are immune.

It is important to remember that man may also contract glanders from diseased horses.

Symptoms.—*" Hidden " Glanders*.—A horse may be affected with glanders and show no particular symptom beyond a general unthriftiness, and is then often looked upon by those in the stable as " a bad doer." This form of the disease is spoken of as " occult " or " hidden " glanders, and can only be diagnosed by the aid of the Mallein Test.

Occult glanders in a stable is a serious matter. Animals so affected may at any time develop some slight discharge from one or both nostrils which is either continuous or appears at intervals. Such a slight discharge, especially if it only appears at intervals, is frequently not observed, or when seen is often not regarded with any suspicion until the animal " breaks up " and develops more advanced symptoms of the disease or dies from glanders. During that time, however, the horse may have infected healthy horses and even human beings.

Not infrequently cases of occult glanders are discovered at the post-mortem examination of animals which have died from other causes, and were not suspected during life.

Typical Glanders.—In typical clinical cases of glanders there is a thick grey-coloured discharge from one or both nostrils. Ulcers and ulcerous patches are to be seen inside the nostrils, and the glands under the jaw are enlarged and hard, forming a lump which is commonly known as a "jug." The temperature may be raised, but in chronic cases it may be no higher than the normal.

Acute Cases.—In severe and acute cases the temperature is several degrees above normal and the animal shows distinct symptoms of respiratory disease.

Farcy.—In farcy one or more limbs become swollen. The lymph vessels stand out prominently on the inside of the limbs. They have a cord-like feel to the hand, and small nodules appear along the course of the vessels. These nodules frequently burst and become ulcers which discharge a thick yellow fluid of oily appearance. The ulcers may heal and leave a scar, but they usually break out again.

Farcy may also appear on the skin of the neck and body.

Post-Mortem Examination.—On post-mortem examination, in addition to the lesions already described, one may find ulceration of the throat and air passages, or, more commonly, small shot-like nodules are present in the lungs. They are formed by tissue products due to the action of the glanders microbes contained within them. The nodules vary in numbers from one or two to hundreds.

Virulent Material and Method of Spread.—The discharges from the air passages in the case of glanders and from the sores of farcy are very virulent because they contain the microbes which cause the disease.

Glanders is spread to a healthy horse either directly by contact with a diseased horse, or, indirectly by such things as mangers, buckets, harness, grooming and stable utensils, sponges, contaminated food or water, and in fact anything upon which a glandered horse has left some virulent discharge.

Preventive Measures.—The spread of glanders to healthy animals can be prevented by the removal and proper destruction of all diseased animals, and a thorough disinfection of all places and articles which are liable to have been contaminated by the virulent discharges.

The complete eradication of the disease from any premises is not, however, to be looked for unless the Mallein Test be applied to all animals showing suspicious symptoms, and to those animals which have been in contact with a diseased or suspected animal and which may therefore be affected with occult glanders.

The application of the Mallein Test requires some skill and experience, but it is quite a reliable test for the detection of occult glanders in the hands of a veterinary surgeon.

A warning is desirable (especially to those who are brought into contact with horses) that a human being may contract glanders from a diseased horse by inoculation through a wound or by rubbing a mucous membrane, such as that of the eye, with soiled fingers, and that care should therefore be exercised in the handling of horses or the carcasses of horses which may be affected with the disease, or suspected of being so affected, in order that this risk may be avoided.

In any case where handling is necessary the hands should be immediately afterwards washed with soap and water to which some suitable disinfectant has been added in the prescribed proportions.

Duties of Owners and others as to Notification of Glanders.—Under the Glanders and Farcy Order of 1929 made by the Ministry, it is the duty of every person having or having had in his possession or under his charge any diseased or suspected horse, ass or mule, to give immediate notice of the fact to a constable of the police force for the police area wherein the diseased or suspected horse, ass or mule is or was.

The duty also applies to every person licensed to slaughter horses in respect of a carcass of any diseased or suspected horse, ass or mule in his possession.

Under the same Order, a veterinary surgeon or veterinary practitioner who in his private practice is employed to examine a horse, ass or mule, or the carcass of such animal, and is of opinion that the animal is diseased, or was diseased when it died or was slaughtered, or suspects the existence of disease therein, shall with all practicable speed give notice of the existence or suspected existence of disease to an Inspector of the Local Authority for the purposes of the Diseases of Animals Acts. A fee of 2s. 6d. is payable by the Local Authority for such notification.

Failure to comply with the requirements of the Order renders a person liable to a fine of £50.

" HUSK " OR " HOOSE "

Common Lung Worms of Cattle, Sheep and Goats

The Disease and its Symptoms.—Parasitic worms in the tubes of the lungs, and in the lung substance itself, are frequently the cause of a more or less severe disease in cattle, sheep and goats (see Fig. 6). The name " hoose " or " husk " is commonly used for the condition because of the peculiar spasmodic husky cough which is one of its most prominent symptoms. It is scientifically called *Verminous bronchitis* or *Verminous pneumonia;* the former name is used where the disease is confined to the tubes of the lung (bronchi), and the latter where the lungs themselves become involved.

Affected animals cough only occasionally in the early stages of the disease, but as the number of parasitic worms is increased through the animals remaining on the infected pasture, the cough occurs more frequently and becomes more distressing until, in the later stages, long paroxysms of coughing are seen, with distressed breathing and signs of suffocation. Animals may fall down through weakness during these spasms of coughing.

The presence of the worms in the tubes of the lung causes an irritation which results in the exudation of a slimy fluid (mucus) from the walls of the tubes. This is frequently expectorated during the spasms of coughing, but as the strength of the animal decreases during the course of the disease, and more and more mucus is exuded by the bronchi, the task of keeping these breathing tubes clear becomes too great, and finally death results from suffocation.

As a result of the inflammation of bronchi and lungs and the great discomfort that it causes, " husky " animals fall off in condition with increasing rapidity, diarrhoea develops, the appetite wanes, the breath becomes foetid, the coat is rough, or the fleece dry and unhealthy, and growth in young animals may cease. If nothing is done to remove the animals from the source of continual re-infection, death will frequently result in from two to five months after the first appearance of symptoms.

On a post-mortem examination being made, the bronchi may be found blocked with frothy mucus in which the worms are situated, portions of the lung may be solid and liver-like, while, in sheep, some parts may present a nodular appearance, with greyish yellow areas up to an inch in diameter and small dark spots on the lung surface.

Occurrence.—Verminous bronchitis is caused by two kinds of worms, one of which affects only cattle, and the other only

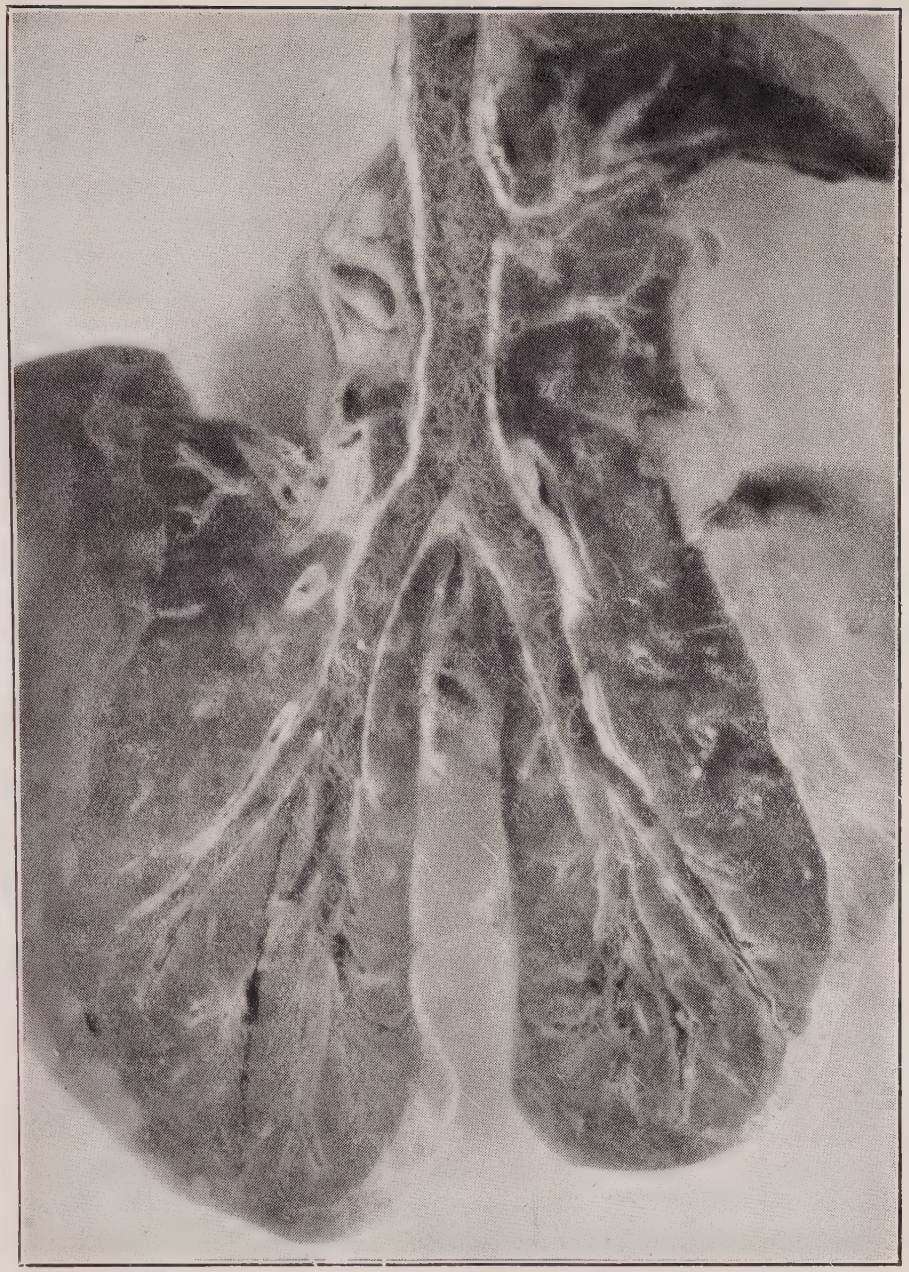

FIG. 6.

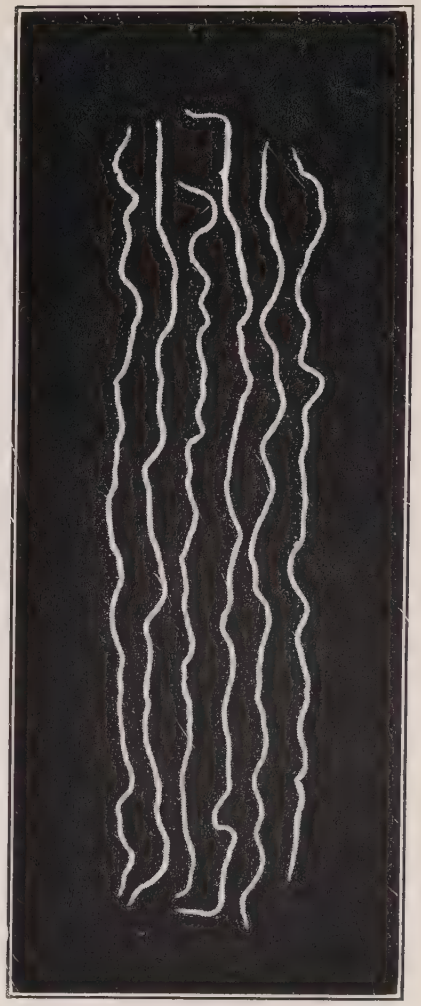

FIG. 7.

FIG. 6.—Sheep's lungs showing exceptionally heavy infestation with threadworms. Part of the lung and the mucus surrounding the worms have been removed so that they may be seen in position in all the tubes of the lung.

FIG. 7.—The mature threadworms of calves—natural size.

[To face page 52.

sheep and goats. It is much less frequent in adults than in animals under twelve months old. The species of worm which inhabits the lung substance and causes verminous pneumonia does not occur in cattle, and is commoner in mature sheep and goats than in those less than twelve months old. It is, however, not unusual to see lambs infected with worms both in the bronchi and in the lungs. These diseases may be seen at any time during the year, but are most prevalent in the spring and summer months, and become increasingly severe towards the months of September and October. Damp pastures and crowded conditions of grazing favour their spread, reasons for which will be found in the account of the life history of the parasite.

Description of the Worms.—The lung worm of calves (Fig. 7) which has been called the " threadworm " is scientifically known as *Dictyocaulus viviparus*. It measures from $1\frac{3}{4}$ in. to $3\frac{1}{2}$ in. long, is white in colour, and very fine and thread-like. It is usually found in the medium-sized bronchi, and causes verminous bronchitis—pneumonia occurring only in the later stages as a secondary condition.

The common threadworm of sheep and goats is called *Dictyocaulus filaria;* it is a little larger than the threadworm of calves, measuring up to 4 in. in length, but its general appearance is the same. It also inhabits the medium-sized bronchi and causes verminous bronchitis.

There are two other species of worm also common in the lungs of sheep and goats, which have been called " hair lungworms " (*Protostrongylus rufescens* and *Muellerius capillaris*). They occur at first in the very small bronchi, and afterwards in the lung substance, where they cause the nodules and greyish yellow areas previously mentioned; these, however, are not always present; the post-mortem examination may simply show large patches of solid lung of the consistency of liver. Hair lungworms cause verminous pneumonia, in which the spasmodic coughing symptoms are not so prominent, and frequently do not appear until the later stages of the disease. Difficulty in breathing is marked, and there is the same loss of appetite and falling away in condition as in the verminous bronchitis, caused by threadworms.

Life History of the Worms.—*Threadworms.*—The adult threadworms live in the medium-sized bronchial tubes, where the females lay large numbers of eggs. Almost as soon as the eggs are laid they hatch, giving rise to minute larval worms (very young worms); these gradually find their way from the bronchi to the wind pipe, and continuing upwards reach

the back of the throat, their progress being assisted by coughing. Some are directly expelled in the frothy mucus during the spasms of coughing, but the majority are swallowed and finally reach the pastures, still alive, in the droppings. The larval worms, which are passed out with the droppings, require to go through a cycle of development before they are able to infect any animal that may pick them up while grazing. The duration of this period is dependent upon weather conditions, a certain amount of moisture and warmth being necessary to their development; it may vary from 4 days to 2 weeks, or more if the weather is cold. Late spring and summer are therefore the most favourable times of the year, and damp, low-lying pastures the best ground for their development. During this period of development in the droppings or surrounding soil, the larvae pass through a series of changes and moult their skins twice. After the second moult they do not completely cast off the old skin, but retain it as a protecting sheath over their proper skin. In this stage they are very resistant to cold and drought, as well as to such substances as lime, salt or bluestone which may be applied to the land in an effort to kill them, and although the great majority will die if not picked up by a grazing animal of the right kind within twelve months, some few may remain alive for even longer periods.

During the night and on cloudy days these infective larvae have the habit of climbing on to blades of grass in the dew or rain on their surface, but the majority as a rule descend again into the soil when exposed to direct sunlight. When such larvae, which have completed the cycle of changes on the ground, are taken with the grass into the stomach of the grazing animal, their development continues, they pass through the membranes of the intestine to reach the intestinal lymphatic glands, thence to the blood vessels; they are carried by the blood to the lungs, and finally reach the bronchi, where they develop to maturity.

Hair Lungworms.—The adults inhabit the very small bronchial tubes and the substance of the lung, where the females lay large numbers of eggs. After egg-laying has ceased they work their way further into the lung substance and cause the nodules previously mentioned. These nodules sometimes become infected with bacteria (germs), and abcesses may form. After the eggs are laid the larvae soon appear and find their way to the pasture in a like manner to those of the " threadworm." In order to continue their development, it is necessary for these larvae to enter the muscular parts

of slugs or snails. This they do either by penetration from outside or from inside, after having been swallowed with the snail's food. The larvae grow a little in the snail, and in about 12 days reach the stage at which they are able to infect a sheep. One slug or snail may carry many larvae and the sheep becomes infected by picking up snails along the herbage. The subsequent migration of the young hair lungworms from the intestine to the lung of the sheep is similar to that which has already been described in connexion with the threadworms.

Prevention.—To cause disease these worms must be present in large numbers. As will be understood from the account of the life history, their numbers cannot increase in the animals' body, but every adult worm present in the lungs must have been taken in with the grass. Crowded conditions of pasturing are therefore carefully to be avoided, as under such conditions, not only are more larvae dropped into every square yard of ground, but the chances of each individual larva being quickly picked up are greatly increased. A little less crowding may make all the difference.

Wet pastures favour the development and preservation of the infective larvae and are frequently infested with slugs and snails; particular care must be observed in grazing such land.

Pastures which are known to be infected should be grazed by older stock.

If the pastures are infected with sheep lungworms only, they may be grazed by cattle of any age, as lungworms of sheep cannot live in cattle. In a like manner pastures known to be infected only with cattle lungworms may be grazed by sheep of any age. In changing the kind of stock on a pasture in this way, it must not be overlooked that pasture favourable to the development of one kind of worm will also be favourable to the development of another, and if any kind of stock is kept there under crowded conditions, worms will be sure to make their appearance before very long.

Where hair lungworms are concerned, an obvious line of attack is the control of snails, and in this connexion great benefit is likely to result from dressing the land with copper sulphate, as advised for the destruction of the snail in which the liver fluke develops (see section Liver Rot, pp. 27-35).

It is an excellent practice to change the kind of stock pasturing a piece of land from time to time, while mixed grazing is always greatly to be preferred over grazing with one kind of stock only. Mixed grazing ensures that the particular species of worms which infect each kind of animal will be comparatively widely scattered over the pasture.

On moderately infested land it is a good plan to keep the animals indoors until the dew has dried. By this time the majority of the larvae have descended from the grass blades, and the risk of infection, though not entirely avoided, is considerably lightened.

Where land is badly infested, the only course to be taken is the removal of all susceptible animals for a period of not less than twelve months, during which time the majority of the larvae will have perished.

Another point which should not be overlooked is the disposal of the manure from infected animals. Lime or disinfectants should *not* be added, but the heap should be made compact, so as to have as small a surface as possible, and ample time allowed for decomposition to proceed. Before carting to the fields the outside 6 or 8 inches should be removed and set aside for inclusion in the next heap. The addition of horse manure greatly assists the process of decomposition, and hastens the destruction of the larvae.

Curative Treatment.—The injection of drugs into the wind pipe is considered by some to give good results. This form of treatment is extensively practised, but should be undertaken only by a veterinary surgeon. Fumigation and chloroform inhalation are also reported to have given satisfactory results, but are dangerous to apply, and here again the services of a veterinary surgeon should be requisitioned.

It is popularly supposed that various volatile drugs, such as turpentine, which are in part excreted by the lungs, will, if administered by the mouth, kill the parasites during the process of excretion. These drugs are, however, excreted by the lungs in such small quantities as to be quite harmless to the parasites, and the treatment is not effective.

None of the above-mentioned medicinal treatments has given much promise under experimental conditions, and the only sound course left open, where once the disease has made its appearance, is to feed and house the affected animals well, and to remove them from the infected pasture where they are continually picking up more worms. These measures will do a great deal towards insuring their final recovery.

LAMB DYSENTERY

Lamb Dysentery is the name given to a disease that attacks young lambs, usually within the first 2 or 3 weeks of life, associated with an acute inflammatory condition of the small and large intestine with haemorrhages and ulcers. The faeces are usually, but not invariably, blood-stained.

The disease is widespread in certain districts in Great Britain, and has been referred to in various parts of the country under such names as " Scour ", " Red Scour ", " Lamb Disease ", etc. It appears to be most prevalent in the north of England and in the Border counties of Scotland. In some districts, certain hill farms have been known for a long time as " hogging " farms because it had been found impossible to rear lambs on them, and it became the practice to use such farms for the grazing of yearling sheep.

The disease occurs only in very young lambs; in the smaller hill breeds usually in the first fortnight of life, but in the larger breeds lambs up to a month old or more may be affected. The condition occurs only during the lambing period, probably on account of the fact that it is only at such times that a supply of susceptible animals is available. The disease is most commonly met with among pure-bred Blackfaces, Cheviots and, in certain areas, Welsh sheep.

Cause.—Various germs have been incriminated as the causal agent of this disease since it came under investigation, but it seems that an organism of the *Clostridium welshii* type plays the primary role in causation.

Symptoms.—It appears that the infective agent enters the body by way of the mouth, and that the lambs acquire infection soon after birth. The onset of the disease varies in acuteness. In very acute cases the lamb is found dead without any illness having been noticed. In the less acute type of the disease, the affected lamb is disinclined to suck, arches its back, lies down and is unwilling to move. The animal appears to be in pain and strains to pass faeces, and though sometimes no action of the bowels may result, more often some mucus is passed and there may be blood in the excrement. Dullness and stupor are the most obvious symptoms. If the animals live long enough, diarrhoea and dysentery set in, and the hind quarters become soiled with blood-tinged faeces. In the less acute forms of the disease the animals may be ill for hours or even days before death occurs.

As a rule, affected lambs die between the 3rd and 10th days of life, but some may succumb within 24 hours of birth. The mortality among affected lambs is probably about 90-100 per cent., though there is evidence of the occurrence of mild attacks, and of recovery after fairly acute attacks.

Lesions.—Two main types of the disease have been described: an ulcerative type and a haemorrhagic (acute inflammatory) type, but mixed forms may also occur.

In the ulcerative form the most important changes are found in the intestines. In acute cases, the most obvious lesion is a haemorrhagic inflammation of the bowels, but careful examination of the small intestine almost invariably reveals at least one or two ulcers from about the size of a pinhead to that of a three-penny-piece or larger. In less acute cases in which the animals live longer, ulcers may be more numerous and may attain a diameter of about $\frac{1}{2}$ in. or more in one direction. The lesions found in the small and large intestines differ according to their location; in the former there is a tendency towards multiple ulceration with limited areas of inflammation, whilst in the latter there is a tendency for the haemorrhagic inflammation of the bowel alone to develop. There is a great tendency for adhesions to form between adjacent loops of the bowel and the bowels and other abdominal organs.

Spread of the Disease.—Outbreaks appear to run a more or less uniform course. On hitherto clean farms the disease usually appears with a few casualties towards the end of the lambing period. During the seasons that follow, the losses progressively increase and eventually settle down to about 30 per cent. of the lambs. For some years the death-rate remains about 30 per cent., and then gradually declines, probably on account of the flock having acquired a certain degree of immunity. As many as 300 lambs have been lost on a single farm in one season.

On affected farms, the first 8-10 days of lambing usually pass without losses, but during the next fortnight losses begin to occur and gradually increase.

The infective agent is known to be present in the faeces of infected lambs, and it appears that the causal organism gains access to their system by way of the alimentary tract. Certain practices may facilitate the spread of the disease, as for example, the custom of " twinning " healthy lambs on to ewes that have lost their lambs from dysentery, particularly when the skins of dead animals are placed on the " twinned " lambs; also the practice of " shedding in " ewes for lambing, which gives rise to unhygienic conditions that favour the spread of infection. The disease may be spread by shepherds handling affected animals and then attending to healthy ones.

It appears that the infective agent is able to survive from one lambing season to another in the soil on infected farms, and it is possible that adult sheep on infected premises may carry the causal organisms in their alimentary tracts or on their fleeces.

Diagnosis.—The fact that a number of young lambs have died and that others are ailing should lead an owner to suspect the

existence of Lamb Dysentery and he should not hesitate to consult a veterinary surgeon so that the disease may be definitely diagnosed early, and the necessary preventive measures applied as soon as possible to combat the spread of infection.

Control and Preventive Inoculation.—On farms where the disease has broken out, all affected lambs should be destroyed, as they may be regarded as the " factories " that " manufacture " and disseminate the infective agent. The carcasses of such animals should be buried in quick-lime together with any surface soil that is known to have been contaminated. Persons carrying out the destruction of such animals or the disposal of the carcasses should realize that their hands, boots and even clothing may have become contaminated with the infective agent, and steps should be taken to cleanse and disinfect the soiled parts as far as possible. Care should be taken to avoid such practices as tend to spread infection (see *Spread of the Disease*). Healthy susceptible lambs may be treated in the manner described below.

Excellent results in protecting lambs against infection have been obtained by the use of an antitoxic serum procured by inoculating horses with toxin produced by organisms of the *Clostridium welchii* type, which have been isolated from cases of Lamb Dysentery. This antiserum should be administered subcutaneously in doses of 5 cc. to all lambs born on pastures where disease exists. The serum should be given as soon as possible after birth.

To prevent the recurrence of the disease on infected farms a method of vaccinating the ewes has been devised. The animals are inoculated with a toxin-antitoxin mixture prepared from organisms of the *Clostridium welchii* type. The ewes are inoculated twice, once in the autumn, and again in the spring shortly before lambing. This is done with a view to immunizing the ewes so that they, in turn, may transmit the protecting substances to their lambs, which will then be rendered passively immune. Variations occur in the degree of immunity produced in different ewes, but it appears that the majority of animals vaccinated in such a manner acquire a sufficiently strong immunity to be able to protect their lambs against infection throughout the period during which the lambs are susceptible; it sometimes happens, however, that a ewe gives a poor response to the inoculation, and such an animal may be unable to give protection to its offspring, which may die of the disease. On farms where the ewes have been vaccinated in preceding years a single inoculation may be given shortly before lambing with a view to increasing their immunity.

By means of serum inoculation of lambs and the vaccination of ewes it has been found possible to reduce the losses from this disease to about 1 per cent. or less.

If unaccountable deaths occur among lambs, the services of a veterinary surgeon should promptly be sought to determine the cause, and if lamb dysentery exists, to advise as to the control measures to be taken.

THE SHEEP MAGGOT FLY

(*Lucilia sericata.*)

Green-bottles (*Lucilia*) and Blue-bottles (*Calliphora*) are two genera belonging to the *Muscidae,* an important family of the two-winged flies. One of the green-bottle flies (*Lucilia sericata*) is a very prevalent cause of maggots on sheep, which, when attacked, show the following symptoms:—

(1) Matting together of the wool fibres.

(2) A continual wagging of the tail.

(3) Rubbing and biting by the sheep in their efforts to allay the irritation caused by the maggots.

(4) Much inflammation.

(5) Oozing from the sores of an evil-smelling sticky fluid.

(6) Discoloration of the wool, which falls out, and in bad cases does not grow again.

(7) Rapid loss of condition.

Description of Lucilia in its Different Stages.—*L. sericata* is a bright shining green or blue-green fly, about one-third of an inch long, and about seven-eighths of an inch in spread of wing. The fly, examined with a lens, is seen to be covered with dark bristles, the arrangement of these bristles being used as an aid in distinguishing this and allied species.

The *eggs* are yellowish-white and measure about one-sixteenth of an inch in length.

The *larva* is a legless maggot, capable, however, of an active crawling movement. It measures, when full-grown, up to half an inch or more in length; the head end is pointed and provided with two mouth hooks; the hind end is blunt with tubercles round its margin and two plates carrying the spiracles on its flat surface. Examination with a good lens, of the first segment behind the head, shows the spiracle to be fan-shaped and to bear ten little prominences. Professor Carpenter points out that a blue-bottle maggot would show in the same situation 13 such prominences.

The *pupa-cases* are brown and rounded or barrel-shaped, and the fly when ready issues by a hole at one end.

Life History.—The female fly is capable of laying as many as 500 eggs and fixes these to the wool in clusters of 20 or more. These eggs may hatch in 24 hours, the resulting maggots feeding at first externally and later boring into the skin and flesh. In a fortnight they may be full grown, when they drop away from the sheep and become pupae under cover of the barrel-shaped cases. In certain experiments which have been carried out the flies issued in from less than a fortnight to over a fortnight, according to temperature, and other conditions.

An attack is worse on lambs than on old sheep and the flies are found at work from May onwards until the autumn. Moist, warm, muggy weather, or warm sunshine after showers favours the fly.

Loss.—Direct loss by death is infrequent where careful oversight by the shepherds is possible, such loss being most likely on hill pastures. Unfortunately, for some reason, maggots are now found at much higher elevations than formerly. Indirect loss is heavy owing to the disturbance to the flock caused by the frequent hunting and collecting. "Struck" sheep also thrive badly and are depreciated in value partly from this and partly on account of disfiguration.

Preventive Measures.—(1) *Cleanliness.*—Sheep should be kept thoroughly clean about their hind-quarters. A good measure is to clip the wool of the tail and between the hind legs. The purpose is to clear away any filth and to give as little opportunity as possible for lodgment, for the flies have a keen sense of smell and are attracted to dirty places for their egg laying. Hence it is that sheep suffering from diarrhœa fall such easy prey to the fly.

(2) *Destruction of Carcasses.*—Carcasses of all dead animals, including birds, should be burnt or buried so that they may not serve as breeding places for the fly.

(3) *Dipping.*—As a preventive measure dipping is useful, but as protection does not last beyond a fortnight or so the dipping must be repeated. Good results have been obtained by spraying periodically the parts most liable to attack with a solution of sheep dip, special attention being paid to the back and hind-quarters.

(4) *Dressing.*—The neighbourhood of wounds should be dressed with some deterrent dressing, e.g., an ointment of butter and finely divided sulphur or spirits of tar.

Remedial Measures.—(a) Infested sheep should be isolated.

(b) The maggots are not difficult to kill. They should be picked or rubbed off, or where they have got to work the wool may be shorn a little, the affected parts being dressed with a mixture of turpentine and rape oil in equal parts, or with dilute paraffin oil, and finished off with a dusting of sulphur.

MANGE IN CATTLE

Definition.—Mange is a contagious disease of the skin caused by parasitic mites or acari belonging to the family *Acaridae*, a family which includes the mites causing sheep scab and parasitic mange in horses, asses and mules (*See* pp. 72 and 92).

Three forms of mange occur in cattle in this country, viz., *sarcoptic, psoroptic,* and *symbiotic*. These forms are named after the species of parasite which is the cause of the ailment. Sarcoptic mange in cattle is uncommon. The most prevalent forms are the psoroptic and symbiotic, and these two forms may exist together in the same animal. Cows are most often affected.

Sarcoptic mange is the most serious form. Its gravity arises from the fact that the sarcoptes burrow under the outer skin, forming minute tunnels in which the female lays her eggs. The eggs are hatched and the parasites multiply in the subcutaneous tunnels. The presence of the parasites gives rise to great irritation and discomfort to the animal, and a severe inflammation of the invaded skin is set up. Owing to the burrowing habit of the sarcopt this form of mange is often exceedingly difficult to cure as local applications to the skin cannot reach all the mites.

It is believed that cattle are liable to contract the sarcoptic mange of the horse and of other domesticated animals. In this respect sarcoptic mange differs from the other two forms of mange, which are not regarded as capable of spreading from one species of animal to another.

Mange is spread to healthy cattle by direct contact with affected animals or indirectly by contact with contaminated pastures, cowsheds, and utensils employed about mangy cattle.

The three forms of parasites differ in their habits, and show certain variations in size, shape, and anatomical characters which are readily distinguished when examined under a low power of the microscope.

The causal parasites of the two common forms may under favourable circumstances be seen by the naked eye, and their movements may be followed with the aid of a suitable hand

lens. When they are only comparatively few in number, they are not so readily detected amongst the scab and debris.

The *sarcoptes* are the smallest in size. They are more or less spherical in shape, the head is short and rounded, and they are capable of cutting through the outer skin under which they burrow.

The *psoroptes* are the largest species. They are oval in shape, the head is elongated, and the legs are long and thick, especially the anterior ones. The pedicle at the end of the legs which carries the sucker is long and articulated. These mites do not burrow under the skin but they bite, and feed upon the inflammatory secretions which ooze out on the surface of the skin in consequence of the irritation set up.

The *symbiotes* occupy a middle position with regard to shape and size. They are also oval, the body is slightly notched along its posterior border, and the head is about as broad as it is long. These mites are the least harmful to the animal. They have a tendency to remain in one situation and feed upon the scurf and debris of the skin without biting.

All three forms are provided with hairs on the body and long hairs on the legs, and all have suckers at the extremity of two or more pairs of legs.

The females are larger than the males and more numerous; they lay a varying number of eggs, according to certain conditions, which appear to have a controlling effect on the multiplication of the parasites and the spread of the disease. The eggs are laid over a period (not all at one laying), and some female parasites may lay as many as twenty, thirty or perhaps more. Within a week, at incubative temperatures, the eggs hatch and the minute young parasites (larvae) with three pairs of legs emerge from the tiny shells.

The larvae, after they are hatched, commence to feed. After a full meal they are engorged, and become torpid and motionless. In this condition they undergo what is termed a moult. The interior of the parasites begins to shrink into a ball-like mass, and separation takes place between it and the outer horny covering of the body.

The parasites remain in this dormant condition for from one to two days.

At the end of the first moult a fissure or crack appears along the back of the old parasite, and a new form appears emerging from the opening in the cast or thin outer covering of the previous form.

This new form is termed a nymph, and the parasite has acquired an additional pair of legs during the process. The nymph in turn feeds and undergoes a moult (second moult). The second nymph stage is followed by another moult (third moult) when the fully developed adult male or female emerges from the separated cast. The males pair with the pubescent females, which, after a further moult, commence to lay eggs. In this way the various stages are repeated, and the parasites rapidly multiply. The length of time necessary for a complete cycle to take place, under favourable conditions, is about twelve days. The eggs retain their vitality off the animal for about a week, the time depending on temperature and moisture.

All forms are capable of living away from the animal's body for some weeks, and fresh cases of mange in healthy cattle may occur even after mangy animals have been removed. A knowledge of this fact should at once serve as a warning against the practice of putting healthy cattle into cowsheds which have been recently occupied by mangy cattle, until such places have been cleansed and disinfected. An infected stall or shed, unless its construction and state of repair allow of its being thoroughly disinfected, should not be used for healthy cattle for at least a fortnight, or better for three or four weeks.

Symptoms.—Psoroptic mange is the most common form amongst cattle, but a general description can be applied to the symptoms seen in all forms.

The most common sites of mange are the root of the tail, the neck, the buttocks and the withers. The parts under the jaw and around the base of the horns may also be affected, and if the ailment is neglected the psoroptic form may spread over the shoulders and chest to almost any portion of the body, but it is rare for the legs to be involved.

As a result of a bite by the mite, a small spot of inflamed skin can be seen in the form of a red spot or pimple. The bites increase in number and the pimples become soft and yellow in appearance from the collection of plasma which has escaped from the minute vessels in the injured parts.

These papules break down, run into each other, and form a superficial sore of varying extent.

The exuded plasma dries, sticks the hairs together into hard tufts and in this way the coat begins to look ruffled, and even unsightly in appearance. The biting of the parasites gives rise to an itchy condition of the skin, which causes the

animal to scratch or rub itself against other animals, or any fixed object, with the result that the hairs over the affected parts get rubbed off exposing a bare scabby patch of skin.

From the presence of the parasite, and owing to the continued rubbing by the animal to relieve the irritation, scurf and scales are thrown off, and can be seen on the surface of the skin. Closer examination shows red and yellow blood scabs. The inflammation of the skin is increased by rubbing and there may be wounds or bleeding sores if the animal has been rubbing against rough objects. Large raw scabby areas of skin denuded of hair may be seen.

Amongst the scab, and more especially round the margin of the crust, the mites are usually to be met with in greatest numbers. They may be seen with the naked eye or better still with a hand lens. The multiplication and feeding of the mites goes on around the main scabby parts, and in this way the scabby area is increased in size. Some of the parasites wander on the body and set up fresh centres of scab, or they may be rubbed on to other cattle or objects.

As the parasites leave the older centres of disease these parts become dry and hard. The skin loses its elasticity and becomes parchment-like. It is sometimes wrinkled, and has a corrugated appearance.

The denser scabby parts crack across in all directions and deep fissures or crevices appear, from which blood or plasma escapes. This condition is best seen on the neck and fore part of the body.

As the disease progresses and the irritation is increased the animals become very restless; they are continually rubbing, biting and scratching themselves. They go off their food, the milk yield is diminished, they rapidly lose condition and flesh, and have a very unthrifty and wasted appearance. The affected cattle may become weak, anæmic and debilitated.

It can only be the result of negligence when cases become advanced, as with ordinary care and attention the disease can be detected in its earliest stages, and with proper treatment cured. A good watch should be kept for a chronic case, in which the mites are few in number and the affected parts small in extent. Such a case in a herd of cattle, while it may be the means of spreading the disease amongst the other animals, may itself escape attention.

It is advisable that examination should be extended to the head, particularly under the jaw and around the base of the horns. The point and under surface of the sternum or breast

should also be inspected, as occasionally in individual animals a number of mites may be collected in these situations, showing little, if any, inclination to spread, and causing no special inconvenience to the animal so affected.

The symbiotic form, also spoken of as tail mange, is usually confined to the parts around the base of the tail. It has a distinct tendency to remain localized; only rarely and in badly neglected cases does it spread over the body. With the prompt use of effective remedies it should quickly yield to treatment.

In cases of rapid wasting it should be borne in mind that the symptom may be due to some serious internal trouble such as tuberculosis or other wasting diseases, which reduce the animal's natural power of resistance to the less serious disease.

It has not infrequently been observed that cows appear to become cured spontaneously when turned out to grass in the spring. This usually means, however, that under open air conditions the parasites do not increase at the same rate, and hence the active symptoms are merely less marked.

When the animals are again brought into the sheds in the autumn, the acari (parasites) which have persisted in small numbers resume their activity, and this sometimes leads to an erroneous belief that re-infection has taken place.

Treatment.—In some countries, where cattle are kept in large herds and a number of them are affected at one time, the affected and contact cattle are dipped like sheep in a prepared dip. If the numbers are large the cattle can be driven through a swimming bath, or should a dipping tank for cattle not be available the dip can be applied with a spraying pump.

Another method of treatment is to wash the affected patches on the animal's skin with soap and warm water, and then dress the parts with one of the common mange dressings, such as spirit of tar, linseed oil and sulphur, or an efficient sheep dip might be used. The dressing should be applied twice or even three times at intervals of ten days. In serious and rebellious cases necessitating treatment of the whole body, veterinary advice should be sought.

The litter from an infected animal should be removed and burnt each time after dressing, and the flooring and wood, or other fittings used about affected animals, should be well sprayed with a 5 per cent. solution of carbolic acid in water, or other standard carbolic preparations which are miscible with water.

NAVEL ILL AND JOINT ILL IN NEWLY-BORN ANIMALS

This disease is met with, under such local names as Big Joint, Joint Evil, Schooley, in most parts of the British Isles.

Cause.—The disease is caused by the entrance into the system of the newly-born animal, through its unclosed navel, of germs which may give rise to the formation of pus or matter. It is possible, however, that germs which are not pus-forming, but which may cause serious illness in animals, may also enter the system by the navel wound. These germs are widely distributed in nature, but are found in greater numbers and probably in a more virulent form on those spots frequently soiled by animals, such as farmyards, lambing yards, &c., than in the fields. For this reason permanent foaling and calving boxes and lambing sheds or sites for temporary yards used frequently or regularly are more dangerous places than the pastures.

Symptoms.—Affected animals are noticed a few days after birth to be moving stiffly and to be disinclined to walk or suck. They lie down continually, and with difficulty are got on to their legs. Their joints begin to swell, and often it is apparent that abscesses have formed—the hock, stifle, point of the shoulder and knee being the joints usually affected. In the worst cases abscesses form in different parts of the body (particularly the liver and kidney), and the animal dies from exhaustion or from the poisons produced by the germs of the disease. Other germs which do not necessarily cause Joint Ill may give rise to blood-poisoning, and kill the animals more quickly, with symptoms of brain trouble and diarrhoea.

NAVEL ILL IN FOALS AND CALVES

Prevention.—Every outbreak on a farm may add to the number of these germs, and so increase the probability of future attacks. On the other hand, if outbreaks are prevented, the germs become fewer in number.

Efforts must then be made to prevent the occurrence of cases on a farm by preventing the germ gaining access to the navels of newly-born animals and to the system through the imperfectly closed navel. In foals and calves this object is best attained by ligaturing the umbilical cord (navel string) immediately after birth with a piece of strong string which has been soaked in 5 per cent. solution of carbolic acid in water, or in any equally effective disinfectant, and by applying a disinfectant to the navel in the form of an ointment or in solution.

If an affected animal is housed in a building, the final disinfection of the building and the litter after its removal must be very thorough.

Treatment.—The disease in foals and calves should be treated by a veterinary surgeon, for the animal's life and future usefulness often depend on careful nursing and skilful administration of drugs, while surgical knowledge is indispensable when it is necessary to open deep-seated abscesses.

NAVEL ILL IN LAMBS

Prevention.—As this disease among lambs more often assumes epizootic characters than among foals and calves, the preventive measures to be adopted to safeguard lambs are given in greater detail.

1. A site for lambing the ewes must be chosen, as free from infective material as possible, and there is no doubt, other things being equal, that ewes lambing in the fields rear a greater number of lambs than those in temporary or permanent lambing yards. Shelter, if necessary, can be provided by strawed hurdles set up about the fields in the form of a cross, or arranged to break the prevailing winds. The lambing field should, if possible, be changed each year.

2. The system in vogue in some counties of passing the whole flock of ewes, if a big one, through one lambing yard cannot be too severely condemned. A large flock should be split into as many divisions as convenience will allow; it is then possible to confine disease to the division in which it occurs. If the lambing yard system is adopted it is imperative that a fresh site should be chosen each year.

3. All dead lambs and the membranes in which they are born should be buried promptly. Straw on hurdles and for bedding should be renewed occasionally, and hurdles should be lime-washed. Manure and straw from hurdles should be placed in a heap and burnt and should never go on to sheep pastures. At the end of the season the site of the yard should be sprinkled with lime and the hurdles lime-washed.

4. Care should be taken that the shepherd does not carry disease from ewe to lamb or from lamb to lamb. A shepherd's hands must be continually and scrupulously cleansed with soap and water. They must also be disinfected, the nails being kept short and scrubbed with a nail brush. His clothes should be covered with a lambing coat which should be frequently washed and disinfected. Dead ewes or lambs should not be skinned by the shepherd.

5. A little disinfectant should be applied to the navel of each lamb immediately after birth. Stockholm tar has been found useful for this purpose.

6. A ewe which has given birth to a dead lamb should not be allowed to run with the healthy ewes and lambs. If a ewe loses her lamb from this disease it is not safe to " mother " a fresh lamb on to her, as this lamb often becomes attacked. The expedient of putting the skin of a ewe's dead lamb on another to be adopted by her should on no account be resorted to.

7. A ewe which has lost her lamb should be carefully watched, as it is possible that germs from the lamb may have found their way into her teats and produced inflammation of the udder, which, if it does not kill the ewe, will probably prevent the gland secreting milk in the future, and so render her unfit to breed again.

8. The site of the lambing yard in which diseased lambs became infected should be immediately changed and the hurdles re-strawed and disinfected. If an infected field is believed to be responsible, the sheep should be moved on to fresh ground. In this way it is possible to avert a serious outbreak.

Treatment.—When the disease appears in lambs the advice of a veterinary surgeon should be sought as regards treatment of the affected, prevention of spread of the disease in the flock, and means to avoid unnecessarily soiling the farm.

If the smallness of the flock or distance from a veterinary surgeon renders veterinary advice out of the question, the following measures should be adopted:

The affected lambs, with their mothers, should be isolated on a spot not likely to be used for sheep for some time. If only a few lambs are attacked it will be found cheaper to kill them and dry off the ewes, as only a small percentage of survivors grow into sheep which show a profit. If a large number are attacked, it is then worth while employing a man to nurse them who does not go near the healthy flock. The symptoms should be treated as they arise. Superficial abscesses should be opened with a sharp knife and then washed with a disinfectant. The evacuated matter should always be disinfected. The udders of the ewes should be carefully examined, for the lambs sometimes infect them. Bottle feeding will be necessary for the worst cases, and care must be taken that a lamb does not lie always on one side, as the limbs of that side are likely to waste or become paralysed.

THE SHEEP NOSTRIL FLY

The Sheep Nostril Fly (*Oestrus ovis*) belongs to the family Oestridæ or Bot Flies. The mouth parts of this species, as of the other bot-flies, are either abortive or rudimentary, so that as adults they do not feed. The harm is done by the larva or maggot which is parasitic on one of the higher vertebrates; in the case of *Oestrus ovis* the sheep is the host.

The Sheep Nostril Fly has a wide distribution, and the harm done by its maggots is known to flock-masters in Britain from north to south.

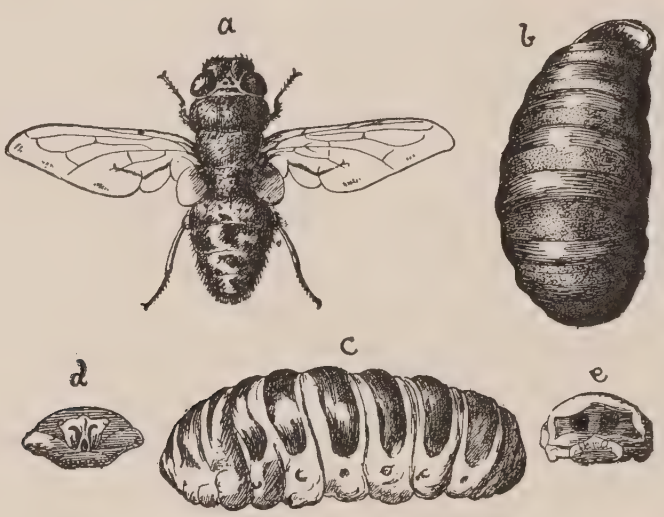

FIG. 8.

THE SHEEP NOSTRIL FLY (*Oestrus ovis*): *a*. Fly; *b*. pupa case; *c*. larva; *d*. head end; *e*. tail end. (*a*. original and *b*. and *c*. twice natural size; *d*. and *e*. after Ormerod, enlarged.)

Description.—*The Fly*.—The somewhat hairy fly (Fig. 8*a*.) measures about half an inch in length; the upper surface of the head is light brown, and that of the thorax light brown or yellow to grey. Dark-coloured tubercles are seen on the thorax; the ringed abdomen is brownish yellow with dark spots, and the legs are brown. The wings are glassy, and extend, when the insect is at rest, beyond the body. The balancers (behind the pair of flying wings) are white, and are covered by well-marked winglets. These winglets are present at the hinder margin of the flying wings.

The Egg.—The eggs are somewhat curved or kidney-shaped.

The Larva.—The newly-hatched maggots are at first very small, white, and wormlike, but they become longer and more rounded at a later stage. They have two hooks directed backwards at the head end, between which is the mouth. Along the under surface of the abdomen are transverse rows of little projections, and on the free end of the last segment are the spiracles or openings of the breathing tubes. Below these is

a lobe with spines, and on each side a little process, both of which play their part in the movement of the maggot. The full-grown maggot (Fig. 8*c*) measures between three-quarters of an inch and an inch in length.

Life History.—The flies leave their shelter places when the weather is sunny and warm. The sexes pair, and afterwards the females fly towards the sheep. Eggs may be laid round the sheep's nostrils, as seen by Mr. Fred V. Theobald, or live larvae may be deposited in the sheep's nostrils. The maggots by their mouth-hooks, anal processes and spines, draw or push themselves up the nostrils. The pricking and wounding of the lining mucous membrane cause much irritation to the attacked sheep. The larvae feed on the secretions resulting from the irritation caused by their presence and their prickings, and they become mature in the frontal and maxillary sinuses of the sheep. Ultimately, the full-grown larvae return to the passages, and are sneezed out on to the ground. Occasionally maggots wander into the recesses of the turbinated bones, where they become imprisoned owing to increase in size, and ultimately die.

The larvae ejected from the nostrils pass the nymphal stage a little below the surface of the ground, under a clod, or sheltered in a tuft of grass. The fly matures and issues from the puparium during the summer, the complete development requiring about 10 months. The number of maggots in a head varies, but it is usually small. Maggots of very different sizes and in different stages of development may be found in the head at the same time.

The following quotation of Bracy-Clark's, from the Volume of the Linnæan Society's Transactions for the year 1797, describes the behaviour of sheep when their enemy is at work:—" The moment the fly touches the nose of the sheep they shake their heads and strike the ground violently with their forefeet, at the same time holding their noses close to the earth, they run away, looking about them on every side to see if the fly pursues; they also smell to the grass as they go lest one should be lying in wait for them. If they observe one they gallop back or take some other direction. As they cannot, like the horses, take refuge in the water, they have recourse to a rut, dry dusty road or gravel-pits, where they crowd together during the heat of the day, with their noses held close to the ground, which renders it difficult for the fly to get conveniently at the nostril." On occasion, however, the sheep may remain quite restful.

Symptoms attending Infestation.—A discharge, which often agglutinates round the nostrils, is observed. The sheep sneeze in their endeavour to get rid of the larvae. They toss their heads and rub their noses on the ground or with their feet. Sometimes they walk along with a high stepping gait and with their heads in the air. They may also exhibit difficulty in breathing from the obstruction of the air passages.

There is a loss of condition attendant on the constant irritation.

Treatment.—In combating the sheep nostril fly, *prevention* is to be aimed at rather than later remedial measures.

1. Attempts may be made to deter the fly from laying its eggs or maggots by repeated dressings of the nostrils of the sheep with such materials as tar or fish oil. As this is an onerous task, contrivances are employed for making the sheep dress themselves. These take the form of salting troughs made in the shape of the letter **V**, the sides of which are smeared with tar, and as the sheep lick the salt they get the tar on their noses. In other cases the boxes containing the salt are closed save for a hole painted over with tar.

2. Where a pasture is known to be infested the sheep should be removed before the flies issue from the pupa cases.

3. Infested sheep should be isolated so that the maggots when mature may not be sneezed out on to the pasture.

4. To prevent further development the maggots when seen should be destroyed.

Remedial measures are not of much avail, and they may be too troublesome and expensive to be generally practised, save with very valuable prize sheep.

Such measures consist in fumigation to kill the maggots or to induce a violent sneezing, which may result in the maggots being ejected. Fluids which, if they reach the maggots, would kill them, may be injected up the nostrils. Cutting into the cavities where the maggots are resident, and picking them out has also been tried with fair success.

PARASITIC MANGE IN HORSES, ASSES AND MULES*

Definition.—Parasitic Mange is the name given to a condition of the skin caused by parasites, known as mites or acari, which belong to the family *Acaridae*. It is a contagious disease, since the parasites may be conveyed to other equine animals.

* *See also pp.* 62–66.

The Parasites.—The mange mites are exceedingly small, round or oval in shape, and usually visible only through a hand lens or microscope. There are several distinct stages in their development; the newly-hatched mites (larvae) have three pairs of legs, but after further development they acquire a fourth pair. The legs are furnished with bristles, claws, and some with suckers. From the head project the feeding organs, and the jaws resemble saws. The body is furnished with scales, spines, and bristles. The adult females lay eggs, which hatch out into larvae in from four to seven days. These larvae, after successive moultings, develop into adults. The mites can exist on moist dung for several weeks, but live for a shorter time on a dry surface. The eggs are said to retain their vitality for several weeks if moisture is present, but in a dry atmosphere only for from three to six days. The mites are killed in a short period if exposed to a temperature of 104° F. or over, but moderate warmth, such as obtains in warm stables and during summer, stimulates them and renders them more active.

Forms of Mange.—Three varieties of parasitic mange affect horses, asses, and mules in this country, viz:—sarcoptic, psoroptic, symbiotic. The mites responsible are distinct in each case, and have somewhat different modes of life.

The *sarcoptic* form spreads slowly, but is the most serious on account of its being the most difficult to cure. The mites known as the Sarcoptes, bore their way through the outer skin, burrow underneath it, and cause irritation to the animal, setting up inflammation of the skin. In the small galleries or tunnels thus formed the mites lay their eggs. It is on account of this burrowing habit that it is difficult to reach the parasites with destructive agents. The mites may attack any part of the body, but they usually locate themselves first about those parts which come in contact with the saddle or other harness, from which they may spread to other parts. The sarcoptic form of mange is analogous to the itch or scabies of man.

The *psoroptic* form generally spreads more rapidly over the body. It is more prevalent than the sarcoptic form. At first it is usually confined to those parts situated near the long hair of the body, such as the neck, withers, rump, and base of tail, but in advanced or neglected cases the parasites may spread all over the body, and may be found on the buttocks and inside the thighs. The mites, which are known as psoroptes, live on the outer surface of the skin, and cling to it by means of their mouths and limbs. They bite the skin to obtain food,

causing irritation and inflammation. Over the injured parts scabs are formed and scurf accumulates, amongst which the mites shelter, feed, and breed. The scab increases in size as the mites increase in number, and each new generation of young parasites selects fresh feeding ground, usually around the edge of the older scab; or the mites may, through the grooming, be disturbed and distributed, setting up additional centres of disease on other parts of the skin.

The *symbiotic* form is probably the most prevalent, but it is not so serious as the two former. It is usually confined to the extremities of the legs, but may also affect the tail. It develops slowly, and only exceptionally invades other parts of the body.

An animal may harbour more than one form of mange at the same time.

Symptoms.—Mange may not always be detected until it has made considerable progress, or the early symptoms may not have been regarded as important by the owner or the attendants.

The first indications are that the animal is restless, appears to be itchy, is incessantly rubbing against any objects within reach, including the pole or shafts of the cart, or against other horses. Affected animals will even bite and gnaw the parts attacked by the parasites, scratch the parts with the hind limbs if accessible, and stand rubbing one leg against the other. They may be seen or heard scraping, pawing, kicking, or stamping the feet a good deal, especially during the night in a warm stable. There may also be switching and rubbing of the tail. When the scabby parts are touched with the hand or passed over with the grooming tools, the animal will lean towards the attendant and manifest a sense of pleasure, which is frequently accompanied by a nibbling movement of the lips. The hair over the affected parts bristles or stands erect, and in more advanced cases is twisted or broken off short. Bare patches of skin are seen, due to the hair falling out or having been pulled or rubbed out. The skin may show an inflamed, pimply surface, with some long or broken hairs still in place, or the part may be quite bare and scurfy. The parasites cause pimples to appear on the skin wherever they bite. Yellowish lymph exudes from the pimples, and helps to form small scabs. This lymph may mat the scabs and hairs together into a hard mass, which may be partly or entirely rubbed off, leaving an excoriated surface. On the hairless parts red scabby spots may be seen, which

readily bleed, and there may be patches of scab containing blood adhering to the skin. In advanced, neglected, and bad cases, the skin loses its elasticity, becomes dry and hard, and is wrinkled or corrugated into folds. Finally, the scabby skin may crack, forming deep fissures. These may bleed and leave nasty, unhealthy looking sores, which in turn may fester or suppurate. There is also an offensively smelling discharge in many cases. If the disease is allowed to proceed unchecked the animal speedily loses condition and becomes emaciated, gets no rest from the incessant irritation, has a very dejected and repulsive appearance, becomes weaker and weaker, and may even die in a state of exhaustion.

In the symbiotic form of mange a horse may do serious injury to its limbs, particularly to the coronet, by bruising it with the opposite foot in making attempts to relieve the itchiness.

Methods of Spread.—Parasitic mange can only be produced by one or other of the previously mentioned mites breeding and multiplying on the animal's skin. A single fertilized egg-bearing female is sufficient to start a case of mange, which in turn may spread to many other animals. All cases of mange can be traced to contagion from an existing or pre-existing case. The parasites can be spread directly from one animal to another, or indirectly through the medium of litter, rugs, bandages, grooming tools, saddles, harness, mangers, stable stalls, loose boxes, stablemen and their clothing and stable utensils. The parasites may be picked up by an animal at an hostelry, on board ship, at sales and fairs, in horse-boxes or railway trucks, at grass, by loan or exchange of harness or by the use of second-hand harness, and from shafts of carts. In fact, anything that has been in contact with a mangy animal, and which has not been subsequently disinfected, may be a vehicle of infection. Given infection, there are certain conditions which, in some animals, at least, appear to be more favourable to the development and spread of the disease; such are low condition and want of grooming. The parasites may live apart from the animal for some weeks in harness, clothing, litter, &c., and may therefore be capable of infecting another animal, or even re-infecting the same animal at a future date.

Treatment.—Mange is not primarily a disease, but a condition of the skin resulting from the presence and action of the parasites or mites, which obtain their nourishment by piercing the skin. The treatment must be directed to the destruction of

the parasites and their eggs, and it is possible to use effective local remedies in the form of skin dressings, which will not only destroy the mites without causing further injury to the inflamed and irritated areas, but will act beneficially by allaying the irritation. The treatment is essentially an external one, but plenty of good food should be given, and if the animal's condition has been reduced or its health materially impaired, tonic medicine given internally may be beneficial. Usually, however, recovery is effected without internal treatment.

It is a waste of time to treat mange by merely dressing the visible patches, because there are bound to be others which have not yet become apparent. To be successful, treatment on each occasion must be applied scrupulously to every part of the body and limbs, particular attention being paid to the nooks and corners, such as under the limbs, under the tail, the base of the ears, the mane, and other hairy parts, and it is advisable that these hairy parts should be kept clipped. *It is also a waste of time to apply dressings but to leave too long intervals between the applications.* The first dressing if properly applied will kill the surface parasites, but it cannot be depended upon to destroy all those in burrows or all the eggs. A second dressing is applied to destroy the larvae hatched after the first dressing, and those which have emerged from the burrows. If this second application is too long delayed the larvae may have become adults and laid a fresh crop of eggs. It is essential, then, that the interval between the dressings should not be more than, say, seven days. Theoretically, two such dressings at the proper interval should be sufficient to cure a case of psoroptic mange, but it is advisable to give at least three. For the cure of sarcoptic mange the interval between the dressings might be somewhat shorter, say, four days, and the treatment should be continued until the case is pronounced cured by the veterinary surgeon in attendance. Sometimes an odd diseased patch may present special difficulties as regards curing. It would be well in such cases to obtain a special dressing for such patches with the advice of a veterinary surgeon, but in addition, the whole body and the legs must be dressed with the ordinary spray dressings.

Prevention.—All newly-purchased animals should be carefully examined for suspicious areas on the skin, and if such are present the animals should be isolated and kept under observation until expert advice can be obtained, but those in charge must not forget that mange caused by sarcoptes or psoroptes in equine animals is a notifiable disease. Care should be taken

not to use second-hand or borrowed harness, clothing, grooming and stable utensils which have not been thoroughly cleansed and disinfected. Owners should be particular about the livery stables which their horses frequent, and litter which has been used for other animals should be regarded with suspicion.

In addition to the isolation and treatment of an animal actually affected with mange, particular attention must be paid to cleansing and disinfecting the stable, litter, harness, and all articles that have been used about the patient. The premises and articles to be included in the disinfection must be reckoned from a time prior to the recognition of the disease.

Lime and Sulphur Dressing for Mange in Horses.—*Ingredients.*—Lime, powdered sulphur and water in the proportions indicated below.

A convenient quantity for a large establishment to make up at a time would be 9 lb. lime and 18 lb. sulphur.

Method of Preparation.—Slake the lime and make into a thick paste with the sulphur. Place the mixture in a strong cloth, tie the ends and suspend in a boiler containing ten gallons of water so that the water completely covers the contents of the cloth. The cloth must not touch the sides or bottom of the boiler, as otherwise the cloth may be burned and its contents escape. Boil for two hours, then raise the cloth to drain, and remove it, taking care that none of its contents escape into the water, and throw the solids away. Make up to ten gallons again with additional water, and put the liquid into a tight drum or barrel.

Application—As a Preventive.—Dilute the fluid with ten times the amount of water, i.e., $1\frac{1}{2}$ pints of the fluid to every two gallons of water, and apply with a spray pump to all parts of the horse's body.

For Affected Horses.—Dilute the fluid with eight times the amount of water, i.e., 2 pints of the fluid to every two gallons of water, and apply with a spray to all parts of the horse's body.

Quantity used.—Two gallons of the diluted fluid is sufficient to treat one large horse.

The best method is to give a first dressing with a tar oil and tar acid dip and to continue with the lime and sulphur dressing.

It is essential that every part of the body and legs be well drenched with the spray.

Spraying Apparatus and Dressings.—Horse owners should place their orders for spraying machines with an agricultural implement dealer; the dressings can be ordered from a local chemist or a dealer in dips.

The Parasitic Mange Orders of 1911 and 1918.—Parasitic mange in horses, asses, and mules is the subject of administrative action in Great Britain, and an Order (the Parasitic Mange Order of 1911), which is enforced by the Local Authority, was issued by the Ministry, under the Diseases of Animals Acts. This Order applies to only two forms of mange, viz., the Sarcoptic and the Psoroptic forms. The Order makes it compulsory for every person having in his possession or under his charge a horse, ass, or mule affected with or suspected of parasitic mange to give notice at once to a constable of the police force for the area wherein the animal is, and also to keep the animal, as far as practicable, separate from other equine animals not affected. In the administrative county of London (including the city of London) the notice may be given to an Inspector of the Local Authority. Every veterinary surgeon who meets with a case of parasitic mange in his practice is required to give notice of it to an inspector of the Local Authority. The Local Authority is required to make the necessary examination with the assistance of a veterinary inspector, who, if satisfied as to the existence of disease, is required to serve a notice on the occupier of the premises requiring the detention and suitable treatment of the affected animal and the other animals on the premises. The Order also provides for the proper cleansing and disinfection, by the occupier, of the premises, harness, stable utensils, grooming tools, or other things used about a mangy animal. The Order makes it unlawful for any person to expose an affected animal in any market, fair, or sale-yard, or in a market lair; to send an affected animal by rail or vessel; to take such an animal along a highway without the written authority of an inspector; or to place such an animal or allow it to stray on common or unenclosed land, or a field or other place insufficiently fenced. Any contravention of the provisions of the Order renders the person or persons concerned liable on conviction to a fine of £50.

The amending Mange Order of 1918 issued by the Ministry recognized the difficult position in which a horse owner may be placed if his horses are suffering from mange, and if he is entirely prevented from making use of them on account of mange. The Order allows affected horses, and those in contact, to be worked under certain conditions which are exceedingly reasonable, namely, that they must be treated regularly in such a way as will effect their cure, and during the curative process render them harmless to other animals. There is no excuse, then, for neglecting to report cases of mange. Indeed,

it is highly foolish on the part of an owner not to do so, since the Authorities are only anxious to be brought in contact with the outbreak in order to have the opportunity of giving further instructions to owners as regards the best method of bringing the outbreak to an end.

Copies of the Orders can be obtained from the Ministry, 7, Whitehall Place, London, S.W.1.

Rules to be Followed for the Prevention and Cure of Mange in Horses.

(1) As a preventive measure, all horses should have their manes hogged and the long hair clipped from the feet and coronets.

(2) As far as possible each horse should habitually occupy the same stall, and the harness of one horse should not be used on another unless it has been previously wiped over with anti-mange dressing, or otherwise disinfected.

(3) Before another horse is put into a stall which has been occupied by an affected or suspected horse, the woodwork, head-rope or headstall, and the floor should be washed over or sprayed with anti-mange dressing.

(4) The harness, stable tools, and cart shafts used in connexion with an affected or suspected animal, should be well dressed with, or soaked in, the dressing, or should be placed in a small room and submitted for several hours to strong sulphur fumes. This should be carried out at least once a week, until the disease or suspicion has been removed.

(5) When a case of mange is found to exist on premises, all the horses, their harness, &c., should be regarded with suspicion, the latter being treated as in (3). The skins of all horses, even though the animals show no outward symptoms of mange, should be sponged over or sprayed once a week (say, Saturday evenings) with anti-mange dressing, special attention being paid to the coronets, the tail and the mane. These should be well soaked with the dressing by means of a water brush or, preferably, a spray pump and afterwards the solution should be brushed into the skin. Special attention should be paid to parts which appear to be rubbed. If the dressing be made up with warm water the horses will take more kindly to the spraying. After being dressed, the horse should be left alone for ten minutes, and then the skin should be wisped over to help drying.

(6) If it be found that the disease is sarcoptic mange an owner should get his veterinary surgeon to see the animal from time to time and prescribe treatment. If it be found that the disease is psoroptic mange, an owner, after receiving the official instructions, can himself apply the treatment to the animal; but it is useless to treat merely the parts visibly affected; the whole skin should be sponged or sprayed with the dressing prescribed. All other horses should also be treated as a precautionary measure.

(7) The litter from an affected horse should be well moistened before removal. It should afterwards be placed on a manure heap well removed from contact with horses.

(8) All new purchases or borrowed horses should be dressed or sprayed as in (5) at least three times.

(9) For the prevention of external parasitism, which is prevalent, and the infection of which may be picked up in innumerable ways, owners of working horses, even when these appear free from parasites, should make a practice of spraying the whole bodies of their animals once a week with a suitable anti-parasitic dressing.

REDWATER IN CATTLE

(*Bovine piroplasmosis.*)

Definition.—Redwater is a popular name applied to a disease of cattle due to the entrance into the blood of very small (protozoal) parasites known as piroplasma. If not identical with the disease described in America as Texas Fever, which is prevalent in many parts of the world outside Texas, the form of the disease met with in England belongs to the same class, that is to say, it is due to the invasion of the red blood cells by piroplasms.

The Parasite.—In 1888, Smith and Kilbourne, working in America, showed that Texas Fever was due to small parasites (*haematozoa*) which invaded the red cells of the blood. These parasites, which are of microscopical size, assume various forms in preparations made from the blood, but they are chiefly either pear-shaped or round, and very frequently the pear-shaped forms occur as twins. This has led to the parasite being named *Piroplasma bigeminum*. In the twin forms found in the Texas disease the pear-shaped parasites are usually joined at their pointed extremities, and the more bulbous parts lie close together or may even touch each other. In 1901 the late Professor Nocard observed similar parasites in the blood of Irish cattle suffering from redwater, and since that date several veterinary surgeons have made similar observations in Great Britain and Ireland. As the result of experimental observations made at the Veterinary Laboratory of the Ministry, by McFadyean and Stockman, and published in 1908, it was shown that the disease known in Great Britain as redwater certainly belongs to the same class of disease as Texas Fever, that is to say, it is a piroplasmosis. On continuing the study of this disease in Great Britain the same observers have found that redwater in British cattle is caused by two species of piroplasms which are clearly distinguishable from each other. One form appears to be identical with the parasite described by Smith and Kilbourne and which is known as *P. bigeminum,* while the other, which is also bigeminate but very much smaller, has been named *P. divergens,* because

the bulbous portions of the double parasites are very widely separated from each other. Numerous observations in connexion with the pathology, method of infection and spread of the British disease, were also made at the Ministry's laboratory and supplemented by other observations made in the field. These observations, which are referred to more particularly below, have shown that while an attack of the one form of the disease protects against a second attack of the same form, it does not protect against the other form. They have also shown, however, that the chief characteristics of the disease are not altered by the fact that two different species of piroplasms are concerned in its causation.

Method of Infection, and Spread.—In 1893, Smith and Kilbourne demonstrated experimentally that the blood of animals affected with Texas Fever, or of those which had recovered from the disease, was infective when injected into other animals which had not previously suffered from Texas Fever. In order to understand properly the method of infection and spread under natural conditions it is important to note that the blood of recovered animals may be infective when inoculated into others, and that experimental observation has proved beyond doubt that the blood of such an animal may retain its infective property for a very long time—it may be for months and even for years. Observations made at the Ministry's Veterinary Laboratory in relation to the blood of animals suffering or recovered from British redwater have shown that such blood is infective to others by inoculation but it would appear that the blood of recovered animals does not retain its virulence for so long a period as in the case of Texas Fever and African redwater, although it may be virulent for several months after the animal has recovered.

Although piroplasmosis is caused by an infecting parasite it is well known that sick and healthy animals may freely mix together in a stable without the latter becoming infected. In fact, one may say that it is impossible to infect healthy animals by allowing them to mix in a stable with others suffering from the disease. Nevertheless, it would be wrong to say that the sick or recovered animals are unconnected with the spread of redwater. The explanation of this apparent paradox is that under natural conditions an intermediate carrier is necessary for the conveyance of the disease from one animal to another. Smith and Kilbourne showed that the carriers of infection from

one animal to another were the progeny of female ticks* which had sucked the blood of animals suffering from the disease or recovered from it. Apparently the infection taken in by the mother-tick passes through the eggs to the larvae, and many of the latter are capable of infecting new animals upon which they afterwards engorge themselves.

It is to be noted that the American tick which carries disease is what is called a " one-sucker," that is to say, when the female larvae attach themselves to a bovine host they remain on the same animal until they are fully engorged and have paired with the males, after which they drop on to the pastures and lay eggs. It is clear, therefore, that were it not for the fact that the infection passes through the eggs of these ticks to the larvae, this class of tick would be incapable of spreading disease, since it stays on the same host during the whole period of its development.

Arrangements were made to have collections of British ticks obtained from cattle and sheep sent to the Ministry's laboratory, and it was found that they belonged to two varieties—*Haemaphysalis punctata and Ixodes ricinus.*† These ticks are what may be termed " three-suckers," that is to say, they feed on three different hosts. The larvae suck for a period on one host, after which they drop off and moult, becoming nymphae. When the moult is complete the nymphae go on to another host and again engorge, after which they drop off and moult into adults. The adults seek a third host upon which to suck. When the adult females are fully engorged and have paired (there is some reason to believe that pairing may also occur after the female has left the host) they drop off to lay eggs, which under favourable conditions hatch into larvae.

There was therefore a possibility that the British ticks might be infective in three stages: (*a*) if an adult female sucked on an infected animal, assuming that the infection might pass through the eggs to the larvae of the British tick the larvae might be capable of carrying infection to other animals; (*b*) larvae might suck on an infected animal and as nymphae (after moulting) convey the disease to the second host; (*c*) the nymphae by sucking on an infected animal might (after moulting) convey the disease as adults to another animal.

* The tick is not to be confused with the common sheep " ked," which is sometimes erroneously called the sheep tick, but which is really a louse and not a tick. (*See* pp. 92–98).

† *See* p. 98.

It is of importance, however, to explain that the infected ticks do not simply convey the disease mechanically, that is to say, the bite of the infecting tick is not comparable to the inoculation of infective blood taken directly from a sick animal. What happens is that the parasite undergoes a cycle of development inside the body of the tick and it is conceivable, of course, that all stages of the British tick may not be suitable to the development of the parasite. From the observations made with British ticks at the laboratory, where *Haemaphysalis punctata* was reared in considerable numbers, it would appear that this is probably the case. Individuals of this species in different stages of development were made to suck on the ears of animals which had been infected with British redwater; the engorged forms were caught in cloth ear-caps, and after they had moulted they were placed on fresh susceptible animals. Experiments with larvae hatched from infected mothers failed to convey the disease. Those conducted with nymphae which as larvae had sucked on infected animals also failed. It was found, however, that adults which had sucked on infected animals as nymphae could convey British redwater to susceptible animals. The number of experiments performed would hardly justify the conclusion that the adult which has infected itself as a nymph is the only stage of the tick which can convey the disease, but it is probable that it is the stage which most frequently conveys it, and certainly the observations put it beyond all doubt that British redwater is tick-borne.

The above experiments were made mainly with *Haemaphysalis punctata*, but field observations show that *Ixodes ricinus* is of equal if not more importance in the spread of the disease. After what has been said about the infective condition of the blood of sick and recovered animals it will be apparent that these animals act as cisterns, as it were, for the prolonged up-keep in their blood or organs of the parasites causing the disease, and that ticks on pastures may become infective and carry the disease to other bovines after sucking on infected individuals.

Seasonal Appearance of the Disease.—The various stages of the British ticks usually remain on the bovine hosts for a period of about five days, with the exception of the adult females, which suck for a much longer time—about ten days.

The time occupied in hatching or moulting varies very much according to the weather. Hatching and moulting seldom take less than three weeks, but may take much longer, even months. March to June and October to November are the

two periods of the year in which the adult forms (which are apparently the most dangerous) are most prevalent in the field. It is at these times of the year that redwater is most frequently met with. Outside these periods, however, odd cases of the disease occur, the reason being that although the periods mentioned are those at which the dangerous stages of the tick are most prevalent, they do not all accomplish the moult at the same time; some are earlier and some are later. The period of time which elapses between infection being received from the tick and the appearance of definite symptoms is about ten days, but it may be slightly longer. It must be emphasized, however, that the ticks of themselves are harmless, and that they only become capable of spreading redwater after they have sucked on an animal suffering or recovered from the disease.

Symptoms.—The disease obtained its name, redwater, because it was believed that the affected animals always passed red urine. The parasite causes a breaking up of the red blood cells, the colouring matter of which is set free. This coloured material is excreted in the urine, giving it a colour varying from dark red to that of black coffee. A clinical study of the disease in the laboratory, however, shows that the parasites may not destroy a sufficient number of red cells to cause the appearance of red urine. In fact, it would appear probable that red urine is not passed by the majority of infected animals, and on this account the disease is frequently passed over. The other symptoms are high temperature, 105° to 107° F.; loss of appetite; severe constipation, and in some cases diarrhœa. It should be noted, however, that the recovered animal may suffer from a relapse, since the infective agent may remain in the body for a considerable time after apparent recovery, and it does not always follow because an animal has clinical symptoms of redwater outside the usual periods of prevalence that it was infected by ticks a short time before the typical symptoms appeared.

Treatment.—The death-rate from redwater in this country is not high, but the disease may cause the animals to fall off very much in condition, and in milch cows it causes a great diminution of the milk yield. Patients require very careful treatment by the veterinary surgeon, who should be called in immediately symptoms are noticed, as the disease is amenable to careful treatment.

Prevention.—One of three methods may be adopted for preventing losses from redwater: (1) preventive inoculation;

(2) eradication of the ticks from the pastures; and (3) purification of the ticks without destroying them. There are many farms upon which ticks are found although redwater does not exist. In stocking such farms with cattle one should be careful not to make use of animals from redwater districts as they often carry the infection in their blood and might easily enough infect the clean ticks.

(1) *Preventive Inoculation.*—If non-infected and susceptible animals be inoculated with a proper dose of the blood of an animal a month or more recovered from redwater they, as a general rule, develop a more or less mild attack of redwater from which they almost always recover. After recovery they present a considerable degree of resistance to future attacks. The inoculation if resorted to, however, should be performed on animals when under cover. The temperature should be taken daily, and on the first appearance of fever the veterinary surgeon will be in a position at the very commencement of the disease to give the animals any medical attention which they may require. For the purpose of reducing losses, inoculation could be usefully performed on susceptible animals before putting them on to what are known to be infected pastures. The great objection to the inoculation method is that the inoculated animals when they go to the pastures are capable of further infecting the ticks. There are certain pastures, however, the nature of which makes it impossible to eradicate or purify the ticks, and under these circumstances one may be forced to fall back on preventive inoculation.

(2) *Eradication of the Ticks.*—If the pastures be heavily infested with ticks, a rather rare contingency in this country, one may attempt to reduce their numbers by dipping the animals while the ticks are attached to them. For this purpose it is well to put a large number of sheep (which have been shown not to be susceptible to redwater) on the pastures as "tick collectors," the sheep being subsequently dipped to kill the ticks.* The best times for dipping to destroy ticks are those mentioned above under the section dealing with the seasonal appearance of the disease. At these periods the adult forms, that is to say, those which when fully engorged will drop off and lay eggs for the continuation of the species, are most in evidence. Moreover, the adult forms remain on the animal for a longer period than the others, namely, 10 days, so that a better opportunity is afforded of getting a large number on the animals at one time. It must be noted that dipping an ox

* *See* pp. 92–98.

already carrying infected ticks will not necessarily prevent it becoming infected. The object of dipping is to get rid of the ticks from the pasture. There are various objections to the dipping method. Close observation shows that none of the dipping materials commonly used have a particularly destructive effect on ticks, nor can they be relied upon to keep ticks off the animal for any considerable time. It may indeed be pointed out that dips for the destruction of ticks have acquired a reputation in excess of their value, owing to the fact that in order to complete their development the British ticks naturally drop off their host in a few days, and the dip thus wrongly gets the credit of having killed them or made them let go their hold.

Purification of the Ticks.—Without destroying the ticks one may get rid of the infected ones from the pastures by keeping cattle off for a time, and this method is the one which promises most finality. The period required, however, is a long one, as the various stages of the tick are capable of prolonged existence in the event of a host not being available. Probably cattle would have to be kept off the pastures for about 14 months to ensure purification. The cleansing of the ticks may be hastened, however, by heavily stocking the pastures with sheep. The latter animals are not susceptible to redwater, and the ticks by sucking on them get rid of their virus without doing the sheep any harm. If it be not possible to utilize the infected pastures for sheep alone, the number of cases of redwater can be greatly reduced by running sheep on the pastures in conjunction with cattle. Many of the infected ticks will then go on the sheep and in this way be diverted from their bovine hosts. The Ministry has reason to believe, from actual observations made at its instigation, that the pasturing of sheep with cattle on infected fields gives good results.

RED-WORM DISEASE OF HORSES, OR STRONGYLIDOSIS

This disease is of considerable importance and is responsible for much loss to horse owners in the British Isles. It is principally confined to young animals grazing on old horse pastures.

Symptoms.—The symptoms are those generally associated with gross intestinal parasitism. In the early stages the affected animal does not thrive well, the coat becomes rough, and loss of condition and weakness follow. Diarrhoea is sometimes present and in severe cases the blood becomes thin (anaemia),

the eyes become sunken, the whole appearance of the animal becomes very dejected and finally death may supervene. These symptoms creep on very gradually, and frequently do not attract attention until some weeks after their onset; the disease may thus reach an advanced stage before the owner observes it and takes action.

Cause.—The cause is the presence of large numbers of " red-worms " in the first part of the large bowel. More than 50 different kinds of these worms have been described and named, and several kinds are usually present at the same time. The three largest are known scientifically as *Strongylus equinus, Strongylus edentatus* and *Strongylus vulgaris;* they are between 1 and 1½ in. long and red in colour. In a freshly killed carcase they may be found adhering to the membrane on the inside of the large bowel. *S. vulgaris* is smaller than the other two species and is the most common. Most of the other species are much smaller, and of a pale pink or dirty-white colour. They may be called the " smaller red-worms " or cylicostomes.

Life-History.—Although the life history of not one of these parasites is known completely, sufficient information is available to give some direction for the framing of control measures. The following gives an idea of the general plan to which all the parasites probably conform.

The mature worms in the intestines of the horse lay very large numbers of eggs, which find their way to the ground with the droppings. In a few hours the eggs hatch and give rise to minute worms. These, however, are not able to infect another horse until they have passed some days or weeks on the ground, during which time a cycle of changes takes place resulting in the development of " infective larvae ". These are minute worms about $\frac{1}{50}$ in. long and enclosed in a double skin, the outer being the old skin which has remained in position since the previous moult. This loose, outer skin acts as a protective sheath and renders the little worm very resistant to the extremes of cold, heat or dryness to which it may be subjected under natural conditions. It can also withstand the action of lime, salt or bluestone applied to the land in an endeavour to kill it. Protected by this sheath it is also able to hibernate for 12 months, or longer, while waiting for some grazing horse to pick it up.

When at last the resting larva is taken in with the grass by a grazing horse, it loses its outer skin and begins its parasitic existence.

Information on the next stage of the life history is very incomplete, but probably all the young worms migrate from the bowel and do not return until they are almost mature. It

is in this immature stage, however, that some of them may do most harm. *S. vulgaris,* probably the most harmful, finds its way through the intestinal wall into the blood vessels, where it produces swellings (aneurisms) in the main arteries that carry blood to the wall of the intestine. Aneurisms derange the circulation of blood to the intestine, and are considered to be one of the causes of colic. The young forms of the two larger species of red-worm, *S. edentatus* and *S. equinus,* may often be found on post-mortem examination of a horse, in the liver, in the fatty tissue round the kidney, in the membrane that holds the intestine in place (mesentery), in the false sweetbread (pancreas) and in several other situations. Here they grow almost to full size, but never gain maturity until they can make their way back to the intestine.

The smaller red-worms do not appear to wander, but only to enter the membrane lining the large intestine. When a horse has been badly infested with these worms the lining membrane of the large intestine shows numerous black spots marking the position of the young worms, whence after a period of growth they return to the bowel contents and develop to maturity.

The duration of the migration period of these parasitic worms (i.e., the time that elapses between taking in the infective larvae from the grass and the appearance in the droppings of the eggs laid by the mature worms), is not known. In the larger red-worms it is probably about 4 or 5 months, but may be much shorter for the cylicostomes.

Propagation of the Disease.—In order fully to understand how to apply control measures by means of a system of grazing, it is necessary to understand how the disease develops.

The presence of the worms is not the only factor in the causation of red-worm disease; they may be found almost everywhere where horses are kept. To produce disease it is necessary for the worms to be present in *large numbers.* It will have been gathered from the account of the life-history that *red-worms do not multiply in the body of the horse,* and that each one of the many thousands which may be present in a heavily infested animal has been picked up as a young worm with the herbage. The presence of many worms in the horse is therefore the result of the presence of many young worms on the ground, and the latter is the result of crowded conditions of horse pasturing. As the young worms are able to live for a long time on the ground, the time factor in grazing is also important, and there is a gradual accumulation of infection on the ground whilst horses are grazing there. Although

the number of worms in the horses and on the pastures may not reach a dangerous pitch for some years, where horses are thickly pastured the time will come when the ground is sufficiently

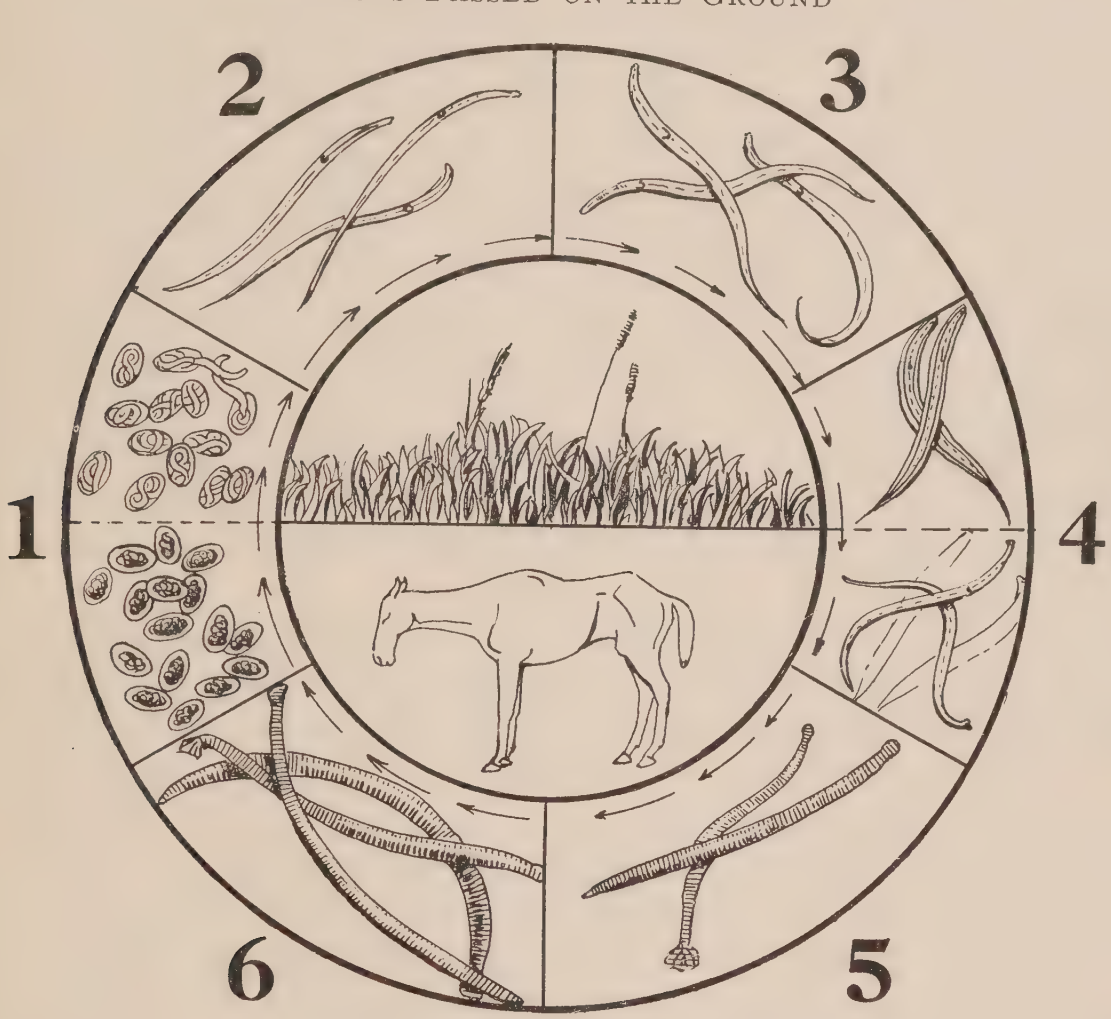

Fig. 9.—Diagram showing the various stages through which the red-worms pass in the course of a life cycle. The stages figured in (1) to (6) are of microscopic size and the figures are, therefore, greatly enlarged.

(1). The eggs are passed in the droppings and hatch on the ground.

(2). The young worm in its earliest stage (first stage larva) cannot infect the horse. In the course of a few days it develops into (3).

(3). The second stage larva. This cannot yet infect the horse, but in the course of a few more days develops into (4).

(4). The infective larva enclosed in a double skin. Can rest on grass for 12 months. It infects the horse and grows into (5).

(5). Young parasite worms in liver, arteries, or wall of bowel, depending upon the species. These finally develop into (6).

(6). Mature parasites situated in the intestine where they lay large numbers of eggs (1).

heavily infested with the larval worms to enable a young horse, during the first two or three years of its life, to pick up a large enough number to cause disease.

Control.—Fortunately there is a reliable treatment for expelling the mature red-worms from the intestine, and in many instances great benefit may attend its use. The most dependable drug for this purpose is oil of chenopodium. Its various actions must, however, be thoroughly understood by those who use it, and at all times it must be prescribed with care, as, like all effective worm remedies, it is a powerful poison. It is therefore safer to leave its use to the veterinary surgeon.

This treatment is, however, of value only for the expulsion of mature worms from the bowel. The immature forms that are found in various organs, and even those found in the wall of the intestine, are not affected by drugs. A young animal that has been grazing on badly infected pasture may show symptoms before the worms have reached the mature stage (i.e., before they have reached the bowel) and become accessible to treatment. Preventive measures are therefore very important and all these should aim at keeping down the numbers of worms in young animals.

In addition to a knowledge of the life-history, the following points should be helpful in arranging a system of grazing that will keep the numbers of worms within the limits of safety.

1. With the exception of mules and donkeys, other farm animals are not susceptible.

2. Aged horses may be pastured with comparative safety on infected ground that would be unsafe for young stock.

3. Mixing grazing is better than grazing with horses alone. It is concentrated grazing with horses that leads to the accumulation of infective material on the ground.

4. Infection can be carried in hay, but the number of young worms that are able to survive the hay-making process is small, so that infected hay used as food can contribute only in a small way to the production of disease.

5. Stable manure should be heaped and allowed to heat thoroughly before it is put on to any ground where horses might be grazed. The decomposition of the manure will not, however, kill the larvae in the outer 6 or 8 in. of the manure heap, and this layer should not be taken on to the fields with the remainder but should be set aside, and placed in the centre of the next heap to be stored there.

Finally, young horses (up to 3 years) should be kept away from pastures that have been much grazed by horses. Overcrowding or long continued grazing with horses should be avoided wherever possible, by mixed grazing or some rotation of pasture. Horses already suffering from the disease should be treated, under expert supervision, with oil of chenopodium.

RINGWORM IN CATTLE

Ringworm is a disease of the skin which may attack any of our domesticated animals, but is most frequently seen on cattle. It is also transmissible to human beings.

It is decidedly more prevalent on young animals such as calves and yearlings, and on stock that are in poor condition.

Cause.—The disease is due to a variety of fungi of which *Trichophyton tonsurans* is one. Microscopic examination of the fungus shows that it consists of two different elements, namely threads or hyphae, and spores.

The hyphae are elongated, straight or waved, and sometimes jointed, tubes, which constitute the actively growing element of the fungus. The spores, which develop from the hyphae, are elliptical or spherical cells with well-defined outlines. From the spores, which are very resistant and may retain their power of germination for months, new growths of hyphae develop in their turn.

Symptoms.—The fungus establishes itself at the base of the hair, which in consequence becomes brittle and breaks off. The irritation due to the fungus causes the skin to become thickened and wrinkled.

Grey, scaly, hairless patches appear on the affected animals, especially on the skin around the eye and mouth, and at the back of the ears, although the patches may be found in almost any position on the skin.

Treatment.—The disease is usually not difficult to cure. In order to enable any substance employed as a dressing to get thoroughly into contact with the fungus, the part attacked should be washed with soap and a solution of washing soda, and the crust removed. The part may then be dressed with one of the following ointments:—

(*a*) Lard five parts, Sulphur one part.
(*b*) Lard or Vaseline five parts, Iodine one part.
(*c*) Soft soap five parts, Sulphur one part.

The application should be repeated daily for three or four days, and again after an interval of a few days.

Mercurial ointment is sometimes used as a dressing, and is very efficacious, but it should not be applied over large areas, as cattle are liable to be poisoned by it. Affected animals should be separated from healthy stock, and be confined to a place which can be easily disinfected. There should be no grooming of an animal affected with ringworm. An animal which has recovered from ringworm should be washed with a

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weak solution of sheep-dip before being allowed to come in contact with healthy stock.

Bedding used by affected animals should be burnt; all woodwork and walls should be cleansed with a solution (1 in 20) of carbolic acid or some other disinfecting agent.

The attendant should wear an overall while handling affected stock, and should wash and disinfect his hands and forearms afterwards.

SHEEP-SCAB

Sheep-Scab may be described as a parasitic rather than as a purely contagious disease, affecting the woolly parts of the body, and due to the presence on the skin of a species of mite or acarus.

FIG. 10.

An immature Sheep-Scab Mite much magnified.

Symptoms of Attack.—One of the first symptoms apparent in a sheep that has contracted scab is restlessness combined with a desire to bite the affected part, or to rub against posts, fences, hurdles, or even other members of the flock. This restlessness is the result of the irritation produced by the mites pricking the skin of the sheep in their endeavour to obtain food. The constant biting and rubbing of the sheep to allay the irritation causes injury to the skin, which is followed by an exudation of lymph, and the formation of crusts or scabs, under the edge of which the parasites and their ova are to be found.

As the mites increase in number they move from the scabs to the more healthy parts of the skin and thus extend the area of the diseased parts.

The injury to the skin is followed by shedding of the wool, and the fleece becomes broken and tufted, or matted together,

FIG. 11.

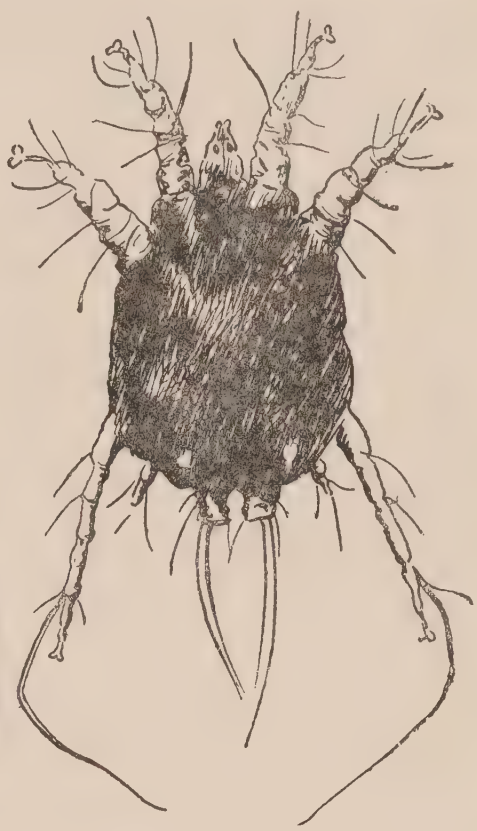

FIG. 12.

Sheep-scab Mites (*Psoroptes communis*). Figure 11, Female × 65. Figure 12, Male, with copulatory suckers extended, × 65.

giving the animal a ragged appearance. Even where the wool does not detach itself from the skin, it assumes a dead-white bleached appearance.

When a sheep is found to present the above symptoms the owner should at once examine the animal, and, if he has any doubt as to the nature of the disease, he should report to the local police constable in order that the veterinary inspector may examine and report whether the itching and rubbing are due to the presence of the sheep-scab mite, or to other causes.

The simplest method of examining a piece of wool or crust taken from a sheep suspected of scab is to spread it out upon a dark surface, and place it in the sun or any other warm position. If it be a case of scab, the mites will frequently be seen as small opaque specks moving about on the wool or perhaps on the surface beneath it. These moving objects should then be examined with a pocket lens or with a microscope of low power, when the parasites and their eggs will present a characteristic appearance.

The parasites and their eggs are usually abundant at the margin of crusts or scabs on the surface of the skin, and if a

small portion of the crust and wool, after being softened in a mixture composed of glycerine and a solution of potash or soda, is teased out and placed upon a microscope slide, there will often be found, in cases of scab, whole mites, or portions of the detached legs, and eggs mixed up with the fibres of the wool and fatty matter.

The parasites of sheep-scab may be seen by the naked eye, but examination is greatly facilitated by the use of a pocket lens, or a low-power microscope.

Description.—*The mature acarus* or mite that causes scab in sheep measures $\frac{1}{40}$ to $\frac{1}{50}$ of an inch (.52—.62 mm.) in length, the female (Fig. 11) being somewhat larger than the male (Fig. 12). Both male and female are provided with four pairs of legs. Each extremity of the first three pairs of legs of the male is furnished with a sucker-disc; but in the case of the female the discs on the third pair of feet are replaced by long hairs.

The egg is about $\frac{1}{125}$ of an inch (.2 mm.) long.

The immature mites or larvae (Fig. 10) have only three pairs of legs.

Parasites very similar in form and size are also found on the horse, dog, and other animals, producing the disease commonly called mange, but these other mange mites do not produce scab in sheep. It may therefore be accepted that where sheep become affected with sheep-scab they must have previously been in contact with diseased sheep, or with fences, posts, hurdles, or other objects against which diseased animals have rubbed.

Life History.—Since the life history of the sheep-scab parasite has a very important practical bearing upon that part of the Sheep-Scab Order of 1928 which deals with the dipping of sheep, it should be explained that after the parasite has been transferred from the diseased to the healthy sheep the female dies after egg-laying is completed. The eggs under favourable circumstances are hatched in about seven days, and the young female parasites, after passing through the various stages of their development, arrive at maturity in about two weeks, when they, in their turn, proceed to lay eggs.

In all instances where sheep exhibit manifest evidence of scab, there are present not only living parasites but also eggs which may be newly laid, or are on the point of hatching. None of the known dipping agents can be relied upon to destroy these eggs. While therefore one dipping, properly conducted, will have the effect of killing the living mites and may destroy some

of the eggs, it is absolutely necessary, if a perfect cure is to be established, to have recourse to a second dipping, which should be carried out not earlier than the 8th and not later than the 14th day after the date of the first dipping (excluding that day), in order that acari hatched from eggs which were not destroyed by the first dipping may be destroyed before they in turn reach the egg-laying stage. If the dipping has been done with proper materials, two dippings will generally suffice, but if any doubt exists, a third dipping should be undertaken after a similar interval.

Preventive Measures.—Where sheep-scab exists, or is suspected, it is the duty of the owner of the sheep, under Article 1 of the Sheep-Scab Order of 1928, to give notice of the fact of the sheep being so affected or suspected to the nearest police constable; but even in the absence of any suspicion of disease, preventive measures against sheep-scab may with advantage be undertaken periodically.

Needless to say, dipping will be effective only if proper materials are used, and if the operation is carried out in a thorough manner. The substances most commonly employed to kill the scab-mite are preparations of arsenic, carbolic acid, tobacco juice, or sulphur. Some flock-masters compound home-made dips, but most rely upon one or other of the many proprietary dips that are now upon the market.

In pursuance of the recommendation contained in paragraph 34 of the Departmental Committee's Report* [Cd. 2,258] on Sheep-Dipping, the Ministry has incorporated in the Second Schedule of the †Sheep-Scab Order of 1928 particulars as to the composition of three preparations which have been proved by experiment to be suitable for use as sheep-dips without detriment to the fleece of the animal dipped, and, if properly employed, to be effective against sheep-scab, as follows:—

Prescriptions for Sheep-Dips for Sheep-Scab approved by the Minister.

(Quantities for 100 gallons of bath.)

1. Lime and Sulphur.

Mix 18 lb. of finely divided sulphur with 9 lb. of good quick-lime. Slake the lime and make into a thick paste with the sulphur. Place the mixture in a strong cloth, tie the ends and suspend in a boiler containing ten gallons of water so that the water completely covers the contents of the cloth. The cloth must not touch the sides or bottom of the boiler, as otherwise the cloth may be burned and its contents escape. Boil for

* This is a Parliamentary publication, and can be obtained, through any bookseller, from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2, price 3d. The volume of Evidence is numbered Cd. 2259, price 2s. 4d.

† A copy of the Order can be obtained on application to the Ministry.

two hours, then remove the cloth, taking care that none of its contents escapes into the water, and throw the solids away. Make up to ten gallons again with additional water and put the liquid into a tight drum or barrel. This quantity is sufficient when mixed with water to make a hundred gallons of dipping bath.

2. Carbolic Acid and Soft Soap.

Dissolve 5 lb. of good soft soap, with gentle warming, in 3 quarts of liquid carbolic acid (containing not less than 97 per cent. of real tar acid). Mix the liquid with enough water to make 100 gallons.

3. Tobacco and Sulphur.

Steep 35 lb. of finely-ground tobacco (offal tobacco) in 21 gallons of water for four days. Strain off the liquid, and remove the last portions of the extract by pressing the residual tobacco. Mix the whole extract, and to it add 10 lb. of finely divided sulphur. Stir the mixture well to secure an even admixture, and make up the total bulk to 100 gallons with water.

NOTE.—The period of immersion in these dips should not be less than one minute.

The Ministry has not included in the above-mentioned Schedule any preparation containing arsenic. There is a possible danger to human beings, attendant upon the preparation of such dips, which renders it advisable that the dips should be compounded by qualified persons only. It is also important to note that a certain amount of risk may be incurred by dipping sheep twice, with a short interval, in a poisonous dip, and that when a poisonous dip is used for the first dipping, it is much safer that a non-poisonous preparation should be used for the second. The Ministry takes no responsibility for any consequences which may arise from the selection of a poisonous dip. Farmers have the choice of a large number of effective non-poisonous dips.

In addition to the above Schedule, it should be noted that there is a large number of proprietary sheep dips on sale, which may be regarded as effective against sheep-scab and which have been approved for the purposes of the Sheep-Scab Order and Sheep Dipping Orders. (Over four hundred preparations have been so approved). An essential point to note is that in order to comply with the provisions of these Orders, the dips used must have been approved by the Minister, and that the Minister's approval is given solely on the grounds that the dip when used as instructed by the makers, may be considered an effective remedy for scab.

Sheep dips approved by the Minister are required to contain sufficient of one constituent to make the dip effective for the cure of sheep-scab at the strength approved. It is, therefore, inadvisable to make up the dip-bath by mixing two or

more dips containing different ingredients, even in cases where each dip has been approved for use by itself. For instance, to mix carbolic and arsenic dips may result in destroying the efficacy of both ingredients, and even the mixing of dips containing the same ingredients may result in the bath being below standard. In some cases also, the use of mixed dips may injure the sheep. Article 41 of the Sheep-Scab Order of 1928, requires that when two or more approved dips are used the resulting bath must be so composed, that the total volume is not more than is required for the dilution of one of the dips, in the proportions in which that dip was approved for sheep-scab by the Minister.

Of the two forms of bath—hand and swimming—the latter is greatly to be preferred. The advantages of the swimming bath are : (1) The sheep, being in a natural position, may be completely immersed, even in a poisonous solution, with comparatively little danger; (2) sheep in lamb may be dipped with much less risk; (3) the motion of swimming allows no portion of the fleece to escape contact with the solution; (4) the work is more easily and therefore more effectively performed; (5) a larger number of sheep can be dipped in a given time and with fewer operators. Different forms of bath are described on pages 99, 100 and 103 and in the *Journal of the Board of Agriculture* for July, 1908.

On pastoral hills, or where the boundary fences are defective, it is difficult, if not impossible, to prevent a certain amount of mixing between sheep belonging to adjacent owners, and it is no easy matter to avoid the risk of attack. On commons the danger of contamination of the flock is still greater. With ordinary precautions, however, scab should be difficult of introduction to a well-fenced farm. These precautions consist in using reasonable care in the purchase of sheep, and in making a point of never bringing fresh sheep on to the ground without first twice dipping them at an interval of not less than 7 and not more than 14 days. If sheep are exposed at a market, without effecting a sale, the animals should be similarly dipped before they are returned to their grazings or are mixed with other sheep. These are safe precautions under any circumstances, and especially so in scab-infected districts.

NOTE.—From time to time the attention of the Ministry is directed to the pollution of watercourses arising from the improper disposal of the dipping material after sheep-dipping has been done. Flock-masters should bear in mind that this residue is necessarily highly injurious to fish and animal life

generally when a poisonous dip has been used, and they should, therefore, always be careful to dispose of it in such a way as to avoid any possibility of its finding its way into streams, ponds or other waters. (See also pp. 102-103.)

SHEEP DIPPING

Sheep scab and the effects of dipping on the parasite causing this disease are dealt with at pages 92 to 98. Dipping, however, is recommended for the destruction or control of certain other parasites, such as keds, lice, ticks and maggots.

The Ked (*Melophagus ovinus*).—This pest, often wrongly called "the tick," is probably the most widely distributed of the parasites which attack sheep. It is a member of the same order (*Diptera*) as the house fly but is wingless. It is about $\frac{1}{4}$ inch in length, has a compressed leathery body, brown-grey in colour, and covered with short hairs. The Ked does not lay eggs; these are hatched in the body of the parent insect and the maggot is nourished there. When the maggot is deposited development is so far advanced that it at once becomes a pupa under cover of a puparium. The brown pupal cases (*puparia*) may be found at the base of the wool fibres. Reproduction is slow, each female producing about three to five pupae at intervals of a few days, after which it dies. Keds are for the most part spread by contact of one sheep with another. The mature creatures cause great irritation and loss of condition.

The Sheep Tick.—*Ixodes ricinus* and *Haemaphysalis punctata* are not true insects, but belong to the *Ixodidae,* a family of the order *Acarina*. On hatching from the eggs, ticks bear only three pairs of legs, but when mature they have four pairs. (True insects in the mature state have only three pairs of legs.) The eggs are laid in large numbers amongst damp herbage; the larvae on hatching attach themselves to sheep or other animals and after feeding fall to the ground and moult, after which they become *nymphae*. Again they reach a sheep and after feeding for a short time fall away and moult a second time, becoming adults. Once more they feed on the sheep as adults and after gorging themselves with blood the females tumble to the ground for egg laying. When fasting they are flat, and move with ease, but the body of the female is capable of great distension and is very much larger when gorged with blood. The large ticks begin to be found on sheep about March, and reappear in autumn. They

are notably common on the hill pastures of the Border districts and in the Western Highlands, though they occur also in other districts.

LICE.—Lice infesting sheep do considerable harm by cutting the wool and causing itching, irritation and unrest. The head of the louse is large and broad; the body is compressed and wingless. The louse is chiefly found on young animals or on animals in poor condition.

MAGGOTS.—The larvae of certain flies (especially the greenbottle *Lucilia sericata*) are a source of great trouble and loss to flock-masters during the summer months. The flies deposit their eggs in clusters amongst the wool, and the resulting maggots feed on the live flesh of the sheep. (For particulars of this pest *see* p. 60).

DIPPING

The operation of dipping is performed in a variety of ways, several types of bath being in common use.

The Hand Bath.—The simplest form of bath is made of wood, galvanized iron, or earthenware, and measures 4 ft. in length and depth and 1 ft. 9 in. in width. In this the animal is immersed by being turned on to its back, its head being held above water. The advantages of this form of bath consist in its low cost, and in its requiring comparatively little liquid to fill it; while its disadvantages are (*a*) the unnatural position of the sheep and the consequent risk of poison " running " into its mouth and nose; (*b*) the laborious and slightly dangerous character of the work for the labourers; and (*c*) the danger of abortion to in-lamb ewes. The hand bath requires more men to work it than the swim bath.

A very convenient arrangement consists of a portable wooden bath 6 ft. long, 2 ft. 6 in. wide, and 2 ft. 3 in. deep at one end, the exit slope commencing 3 ft. from that end. The exit end is bolted to a specially built, crate-like tip-cart, into which the dipped animals walk to drip. The body of the cart is kept horizontal, the shafts being turned down to the ground, the whole being fixed. The sheep leave at the front end by walking down a slope fixed over the shafts. The whole outfit, not including wheels and axles may cost about £10. When not in use for dipping, the cart may be usefully employed as a closed conveyance for calves, sheep, pigs, &c. For a fuller account of this type of bath, together with illustrations, *see* the *Journal of the Board of Agriculture* for July, 1908.

The Swim-Bath.—This bath is made in two forms, being either so narrow (under 2 ft.) that a sheep can only swim forward, or so broad ($3\frac{1}{2}$ ft.) that sheep can swim round in it. A bath much used on the larger pastoral farms in Scotland consists of a trough with sloping ends, 25 ft. long at the top, 18 ft. long at the bottom, and 4 ft. 6 in. deep. The width is 22 in. at the top and 10 in. at the bottom, allowing room for the sheep to pass through the bath in single file only. The bottom of the trough is somewhat narrower than the top. The sheep are put in at one end, and after swimming through the bath, pass up the inclined plane at the other end to a dripping pen.

Full particulars, with diagram, for the construction of an economical swim-bath are given on pages 103 to 106.

The Cage Bath.—A third form of dipper consists of a galvanized tank sunk in the ground with its upper edges flush with the surface. In this a cage is raised and lowered by means of a hand windlass. One sheep at a time walks into the cage, and is lowered into the bath. In due course the cage is raised and the sheep walks on to the draining floor. Under this method the sheep are scarcely handled at all, the labour is easy, and risks of all kinds are reduced to a minimum.

Further information on baths will be found in the Minutes of Evidence of the Departmental Committee referred to below.*

Dips.—In some experiments conducted by Professor Winter, at the University College of North Wales, Bangor, sixteen dips were tested, and of these five (Nos. IV, V, X, XV, XVI) were proprietary.* The sheep were immersed in an ordinary swim-bath for a period of one minute, every sheep being carefully examined at the end of 24 hours, and again at intervals until shorn a month later. A brief summary of the principal dips employed is given below:—

I.—$2\frac{1}{2}$ lb. arsenious acid (ordinary arsenic), $1\frac{3}{4}$ lb. washing soda, per 100 gallons dip-bath.

II.—$2\frac{1}{2}$ lb. arsenious acid, $\frac{1}{2}$ lb. good dry caustic soda, per 100 gallons.

III.—As No. I, with the addition of 4 lb. of finely divided sulphur.

IV.—Combination of arsenic and sulphur, dip-bath containing 5 lb. free sulphur per 100 gallons.

V.—Soluble sodium compounds of sulphur, with free sulphur.

* Report, Departmental Committee on Sheep Dipping, 1904, Cd. 2258; Minutes of Evidence, Departmental Committee on Sheep Dipping, 1904, Cd. 2259; to be obtained from H.M. Stationery Office, Adastral House, Kingsway, W.C.2. Price 3d. and 2s. 4d. respectively.

VI.—25 lb. of sulphur and 12½ lb. of lime boiled in water until of dark red-brown colour; strained and made up to 100 gallons.

VIII.—Carbolic acid ¾ gallon, soft soap 5 lb. per 100 gallons dip-bath.

X.—A fluid carbolic dip readily soluble in cold water.

XIII.—1 gallon of a mixture of 29 per cent. tar acid, 36 per cent. paraffin, 8 per cent. lanolin, 17½ per cent. anhydrous soft soap, and 9½ per cent. water, in 100 gallons dip-bath.

XIV.—Extract of 35 lb. finely ground tobacco and 10 lb. finely divided sulphur per 100 gallons dip-bath at 110° F.

XV.—Small proportion of tar acid in addition to tobacco and sulphur.

XVI.—A tobacco, soft soap, and sulphur dip.

Effects of Dips.—*Keds.*—With the exception of Nos. V and VI, all the above dips were effective in killing keds, but were less successful in their action on the puparia. Generally speaking, the tar acid dips killed keds almost immediately. The tobacco dips were nearly as active, while the sulphur and arsenic preparations required a little longer time.

As the puparia appear to hatch out about 21 days after being deposited by the female, a second dipping at the end of three weeks would doubtless have a marked effect in getting the sheep clear of keds. By that time the puparia left in the fleece after the first dipping would have hatched out and as there is no evidence to show that keds produce puparia within three weeks after they are hatched, it would only be necessary for the second dipping to destroy the keds which had appeared since the previous dipping.

It was evident that where some of the poisonous dips were used, a second dipping after an interval of 12 days was injurious to the health of the sheep, so that where a second dipping is desired for the destruction of keds, the proper time would appear to be about three weeks after the first immersion.

Lice.—There is every reason to believe that any dip which is destructive to other parasites is effective also against lice.

Ticks.—Much misunderstanding has arisen regarding the efficacy of dips for ticks, owing to the fact that in the natural course of their life history ticks leave the host whether the latter is dipped or not. Arsenical dips appear to give the most satisfactory results.

Maggots.—As a preventive measure, dipping is useful, but as protection does not last beyond a fortnight or so the dipping must be repeated. Good results have been obtained by spraying

periodically the parts most liable to attack with a solution of sheep dip, special attention being paid to the back and hind-quarters. (*See* p. 61.)

GENERAL.—Carbolic dips are effective in destroying all sheep parasites, and, when skilfully prepared, leave the wool and skin in a nice condition. The strength should, however, be carefully regulated to prevent irritation of the sheep. Nos. X and XIII were found to be the best, though X discoloured the wool somewhat.

Spirits of tar and pitch oil are apt to discolour the wool and reduce its value.

The arsenic and sulphur dips are thoroughly effective in curing scab and destroying other parasites, but the experiments clearly show that the use of strong dips of this character is attended with some danger when treating sheep affected with scab, especially if they are in low condition or have sores on them. These dips had no bad effects on the quality of the wool. (On the subject of preparing wool for market *see* Leaflet No. 82, obtainable from the Ministry.)

Tobacco and Hellebore dips, if properly compounded, may also be regarded as quite satisfactory.

The exact composition of some dips is given above, and on pp. 95-96, but farmers will find it more satisfactory to use one of the proprietary dips now on the market. Those which have been tested by the Ministry, and approved for use against sheep scab, bear a label to that effect.

The dippers should be instructed to pay particular attention to the upper region of the neck, which often escapes saturation when the swim bath is used. It is advisable to swab this region with dip as the sheep swim through.

Before dipping, all dung-bound wool should be removed by clipping.

Too much care cannot be exercised in keeping the bath free from gross impurities, both by skimming floating particles off the surface, and by changing the fluid at intervals. An old and dirty dip laden with manure encourages rather than retards the attacks of insects.

Warning against Pollution of Streams.—Experiments which have been carried out to test the effects on fish of the dips approved for use against sheep scab have proved that they all contain ingredients which must be regarded as highly injurious to fish and stream life. Care is necessary in disposing of the

residue from dipping baths in such a manner that it cannot injure animals or pollute streams. A satisfactory method is to run the residue from the bath into a trench or pit, the sides and bottom of which have been plentifully sprinkled with lime, so that the liquid from the bath runs through the lime before passing into the soil. This is especially important when poisonous dips are used, in order to avoid the risk of injury to sheep through accumulation of poisonous matter. Under no circumstances, however, should the lime be added to the liquid while it is still in the bath. There is thus no occasion for sheep-dipping to give rise to stream pollution.

Sheep-washing on the other hand *does involve pollution of streams* since the washing frequently takes place in the stream itself, and the waste water is extremely filthy. Amongst the materials washed out of the fleece of sheep are potash salts and soluble organic materials, dirt and grease, the residue of dried perspiration.

Considerable improvement in the quality of the wash-water would be effected merely by removal of the suspended matter. The most convenient way of doing this is to divert sufficient water from the proper stream bed through an artificial gulley into a shallow sump where the actual sheep-washing is carried out. The diversion can be made by systematically piling large stones in the bed of the stream so as to make a dam at an acute angle with the side of the stream nearest the sump. After passing through the sump, the wash-water is caused to flow over grass or moorland before regaining the stream at a lower level. On completion of the sheep-washing, the stones used to divert the water are piled in the carry-off gulley for similar future use. The overflow water from the sump should, if possible, be allowed to drain over at least 100 yards of land before regaining its proper channel. By so doing no fears need be entertained that grazing cattle will be harmed.

AN ECONOMICAL SHEEP-DIPPING BATH

The Advantages of a Good Dipping-Bath.—Sheep-dipping is an essential sheep-farming operation, not only for the cure and prevention of sheep scab, but also for the control of other skin parasites, such as ticks, keds, and lice, and for the general improvement of the fleece. Unless suitable dipping arrangements are available, external parasites cannot be controlled and the use of primitive and unsuitable baths is a waste of time and

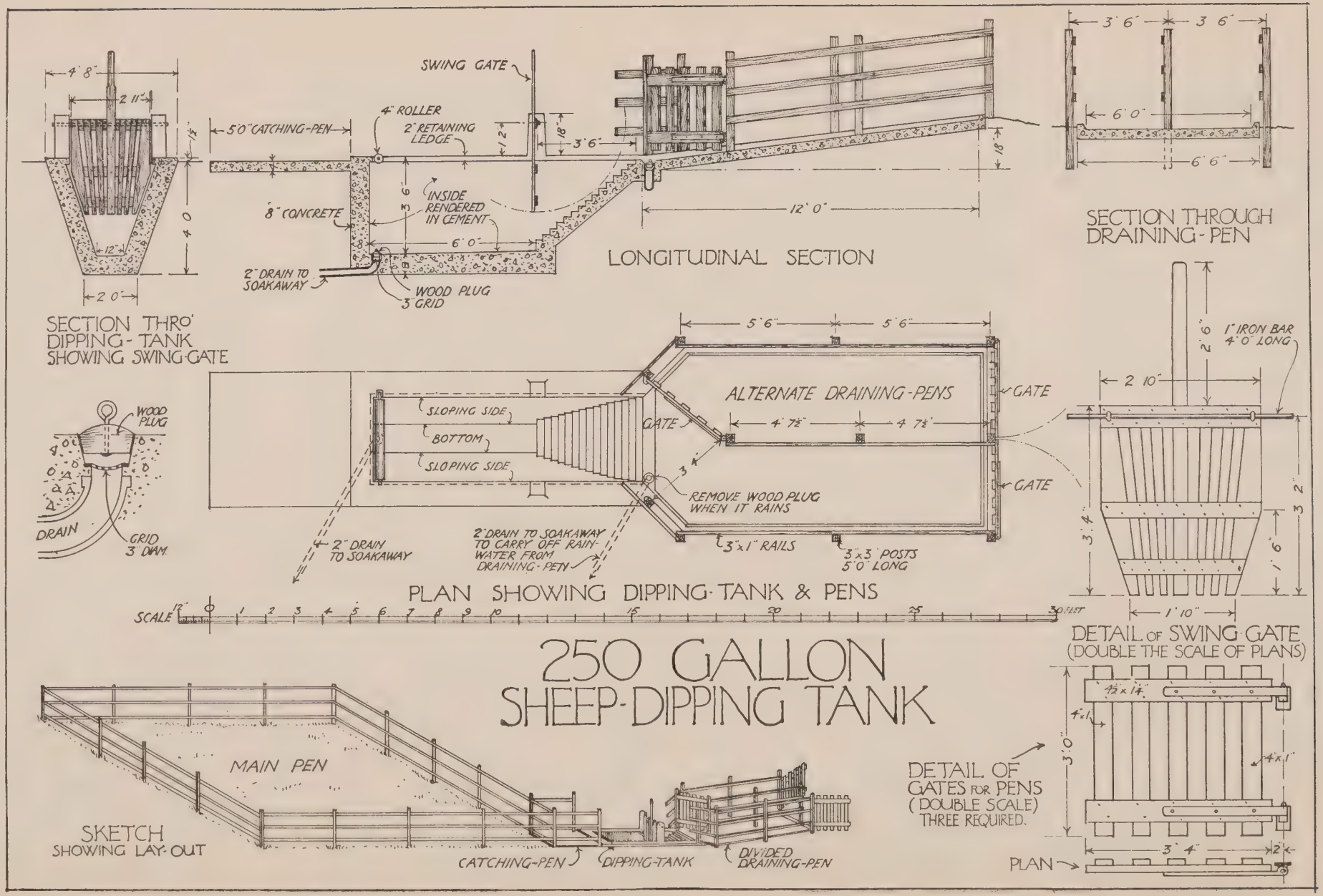
4'8"
2'11"
1'2"
4'0"
1'2"
2'0"
SECTION THRO' DIPPING-TANK SHOWING SWING-GATE
SWING GATE
4" ROLLER
2" RETAINING LEDGE
5'0" CATCHING-PEN
1'2"
1'8"
3'6"
1'8"
8" CONCRETE
3'6"
INSIDE RENDERED IN CEMENT
6'0"
12'0"
2" DRAIN TO SOAKAWAY
WOOD PLUG
3" GRID
LONGITUDINAL SECTION
3'6"
3'6"
6'0"
6'6"
SECTION THROUGH DRAINING-PEN
WOOD PLUG
DRAIN
GRID 3" DIAM.
5'6"
5'6"
ALTERNATE DRAINING-PENS
GATE
GATE
GATE
SLOPING SIDE
BOTTOM
SLOPING SIDE
4'7½"
4'7½"
3"
REMOVE WOOD PLUG WHEN IT RAINS
4" 2" DRAIN TO SOAKAWAY
2" DRAIN TO SOAKAWAY TO CARRY OFF RAIN-WATER FROM DRAINING-PEN
3"x1" RAILS
3"x3" POSTS 5'0" LONG
PLAN SHOWING DIPPING-TANK & PENS
SCALE 12" 0 1 2 3 4 5 6 7 8 9 10 15 20 25 30 FEET
2'6"
1" IRON BAR 4'0" LONG
2'10"
3'4"
3'2"
1'6"
1'10"
DETAIL OF SWING-GATE (DOUBLE THE SCALE OF PLANS)
250 GALLON
SHEEP-DIPPING TANK
MAIN PEN
SKETCH SHOWING LAY-OUT
CATCHING-PEN
DIPPING-TANK
DIVIDED DRAINING-PEN
DETAIL OF GATES FOR PENS (DOUBLE SCALE) THREE REQUIRED.
4½x1½
4"x1"
3'0"
3'4"
1'2"
PLAN

FIG. 13.

money, as the sheep will not receive the full benefit of the dipping. On the other hand, the provision of efficient baths and proper dipping of the sheep in areas where sheep scab was prevalent has been followed by eradication of the disease.

Because sheep-dipping is so important to the well-being of the flock and because of the cost involved in the operation, it is very necessary that the fullest results should be obtained; these can only be secured if a good dipping-bath conveniently situated near a supply of water is provided. Sheep can also be washed very conveniently in a dipping-bath, and this practice avoids the fouling of streams, which is associated with sheep-washing in running waters.

One of the reasons why suitable dipping-baths are not more generally found in sheep-farming districts is the cost of construction. This account is therefore designed to assist sheep farmers themselves to construct an efficient concrete dipping-bath at a comparatively low cost. It is assumed that the excavation and haulage can be done by ordinary farm labour, and that usually the employment of a skilled labourer will only be found necessary for the actual concrete-work. Much of the material required can usually be found on the farm, e.g., sand, gravel, broken bricks or stone for making concrete, and timber or hurdles for fencing and gates.

An approximate estimate of the quantities and cost of materials is given below as a general guide, but costs, particularly for timber, can be considerably reduced where materials are available on the farm.

Size of Bath.—The dimensions given in the diagram (Fig. 13) are for a bath of a capacity of 250 gal., as this size is found the most generally useful. It is ideal for mountain flocks numbering from 600 to 1,500 sheep, and is also quite suitable for other breeds of sheep. The bath is also designed to secure expeditious dipping; and it has been found possible to dip as many as 300 Welsh mountain sheep in an hour, allowing each sheep the statutory period of not less than one minute's immersion.

A larger or smaller bath can be constructed from this diagram by a variation of the length of the bath, a difference of 1 ft. in length altering the capacity by approximately 50 gal. It is not recommended, however, that the capacity should be reduced in this way below 200 gal. The bath of 200-gal. capacity admits of effective dipping of mountain sheep at the 80-gal. mark, and the bath of 250-gal. capacity at the 100-gal. mark. Thus the bath can be used economically even when there is only a small number of sheep to be dipped.

Choice of Site.—When the site for the bath is being chosen attention should be paid to the following points:—

1. Access to water supply.

2. Slope of ground to allow outflow of used dip to run into a sump or other drainage.

Care should be taken that the used dip is prevented from polluting streams or drinking-water, or land used for grazing or feeding-purposes.

3. A reduction in the quantity of fencing required for the catching and draining-pens may sometimes be effected if the bath is made near to existing walls or fences.

Materials Required, Quantities and Approximate Cost

Excavation approximately 47 cubic yards ... ... Own labour

Concrete for bath and flooring of pens.

100 cubic ft. of concrete, at £1 5s. per cubic yard (including skilled labour) £5

The following mixtures are suggested :—

(*a*) Cement ... ... 1 part
Sand ... ... 1 part
Broken brick or stone to pass through a 2 in. screen ... ... 6 parts

or

(*b*) Cement ... ... 1 part
Gravel ... ... 7 parts

A mixture of 1 part of cement to 2 parts of sand is recommended for rendering the sides of the bath.

The total quantity of cement required is approximately 1 ton.

Timber.

(a) *For Fencing.*

	s.	d.
11 oak posts 5 ft. 0 in. × 3 in. × 3 in. at 1s. 2d. each	12	10
6 rails 11 ft. 3 in. 3 rails 9 ft. 6 in. 6 rails 3 ft. 0 in. } × 3 in. × 1 in. spruce. = 114 ft. at 1d. per ft.	9	6

(b) *For Gates* (Spruce).

53 ft. × 4 in. × 1 in. at 1¼d. per ft.	5	6
25 ft. × 4½ in. × 1¼ in. at 1½d. per ft.	3	1
30 ft. × 3 in. × 1 in. at 1d. per ft.	2	6
7 ft. × 6 in. × 1 in. at 2d. per ft.	1	2

Fittings, etc.

1 iron bar 4 ft. × 1 in.	2	0
2 hook bolts for above, ½ in. dia.	2	0
3 pair strap-hinges and gudgeons and bolts	10	0
2 grids for gullies, 3 in. dia.	1	6
2 wood plugs 4 in. dia., with eyes	6	0
1 roller, 2 ft. 10 in., 4 in. dia.	7	6
1 gal. creosote	1	6

N.B.—The cost of outlet pipes is not included as the length required varies according to circumstances.

STOMACH WORMS IN SHEEP

The worms parasitic in the fourth stomach of sheep are a source of great trouble to the sheep farmer, and sometimes lead to very serious loss. Where a severe outbreak occurs it is by no means uncommon for half of the lambs to die, and for the remainder to be so stunted in growth that their market value is greatly reduced. Ewes may also be affected, but this is of less frequent occurrence.

(1) On Pasture Land.—It is on permanent pasture that the disease is usually encountered, and low wet land is generally thought to favour it. Although there may be some truth in this idea, there is no doubt that sheep on the driest of pastures may at times suffer badly. As with all diseases, and particularly with those caused by parasitic worms, overcrowding is an important factor: indeed, the condition of parasitic gastritis in sheep cannot occur without a certain measure of overcrowding. In some parts of the country, farmers have given much attention to the improvement of their grassland by suitable manuring, only to find that along with its increased sheep-carrying power, stomach worms have become so numerous as to harm the lambs. This state of affairs could not obtain while the poverty of the pasture necessitated the scattering of the sheep.

(2) On Arable Land.—Outbreaks of the disease are not uncommon on arable land in districts where frequent catch-cropping is practised, and where sheep are penned over the same area at short intervals. In one case a loss of £4,000 to £5,000 was sustained during a period of five years' farming under this system, solely due to the ravages of stomach worms. As is shown below, the complete control of this disease is in the hands of the arable sheep farmer, providing he is able to make some alteration in his rotation of crops.

The Twisted Wireworm.—There are several kinds of stomach worms occurring in sheep, the commonest being the " twisted wireworm " (*Haemonchus contortus*). This worm (Fig. 14) measures from $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. in length, and is a little thinner than an ordinary pin. In colour it is darker than the wall of the fourth stomach of the sheep, and is tinged with red—due to the blood which it has taken from the sheep. The female worm is the larger, and has a twisted appearance owing to the shape of some of its internal parts which show through the skin; it is tapered towards both ends, and has a small projecting flap about $\frac{1}{4}$in. from one end. The male worm is smaller, and

does not present the twisted appearance or the projecting flap, but at one end carries a comparatively broad membranous portion.

If the fourth stomach (the stomach which is connected directly with the intestine) of an affected sheep be opened soon after death, these worms may be seen moving about in large numbers, and many will be found closely applied to the walls of the stomach. Injury to the sheep is caused by the actual loss of blood, by the irritation of the lining of the stomach (resulting in the derangement of its digestive powers), and by the absorption of a poison which the worms secrete.

The Lesser Stomach Worm.—One other kind of stomach worm warrants special mention: it may be called the " lesser stomach worm of sheep " (*Ostertagia circumcincta*). This worm (Fig. 15) is smaller that the twisted wireworm, and is not easily seen when in its natural position in the contents or on the walls of the fourth stomach. If, however, a small quantity of the stomach contents, or a piece of the stomach wall of an affected sheep be washed in water, these minute worms may be seen like pieces of fine silk in the water, $\frac{1}{4}$ in. to $\frac{1}{2}$ in. in length, and of a dull pink colour. The lesser stomach worm lives in the same position as the twisted wireworm, and affects sheep in the same way.

Distribution.—The two worms described occur in all parts of the world, in sheep, goats and cattle, but are particularly harmful to sheep. They are responsible, in part at least, for causing land which is heavily grazed with sheep to become what is popularly known as " sheep sick."

Symptoms.—The first symptoms of stomach worm disease are general unthriftiness, dry appearance of the fleece, and poor condition. In the later stages diarrhoea appears, the animal becomes very thin and bloodless, the membrane on the inner side of the eyelids and lips whitens, and a watery swelling may appear under the jaws. If these symptoms appear, and nothing be done by way of treatment or removal of the lambs from the source of continual reinfection, many of them will die. In severe outbreaks, where worms are exceptionally numerous, some members of the flock may die suddenly, without previously showing the symptoms above described.

Life History.—A short account of the life history of these parasitic worms will greatly assist the direction of intelligent effort towards suitable measures for control.

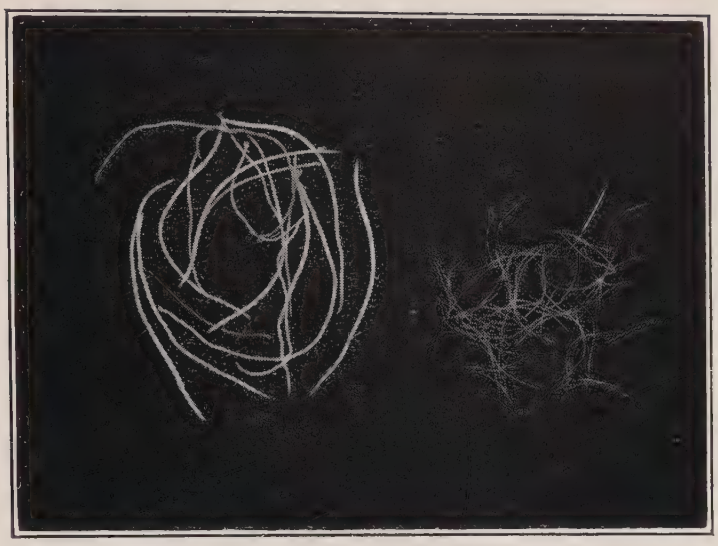

FIG. 14. FIG. 15.

FIG. 14.—TWISTED WIREWORM (*Haemonchus contortus*). Nat. size.
FIG. 15.—LESSER STOMACH WORM (*Ostertagia circumcincta*). Nat. size.

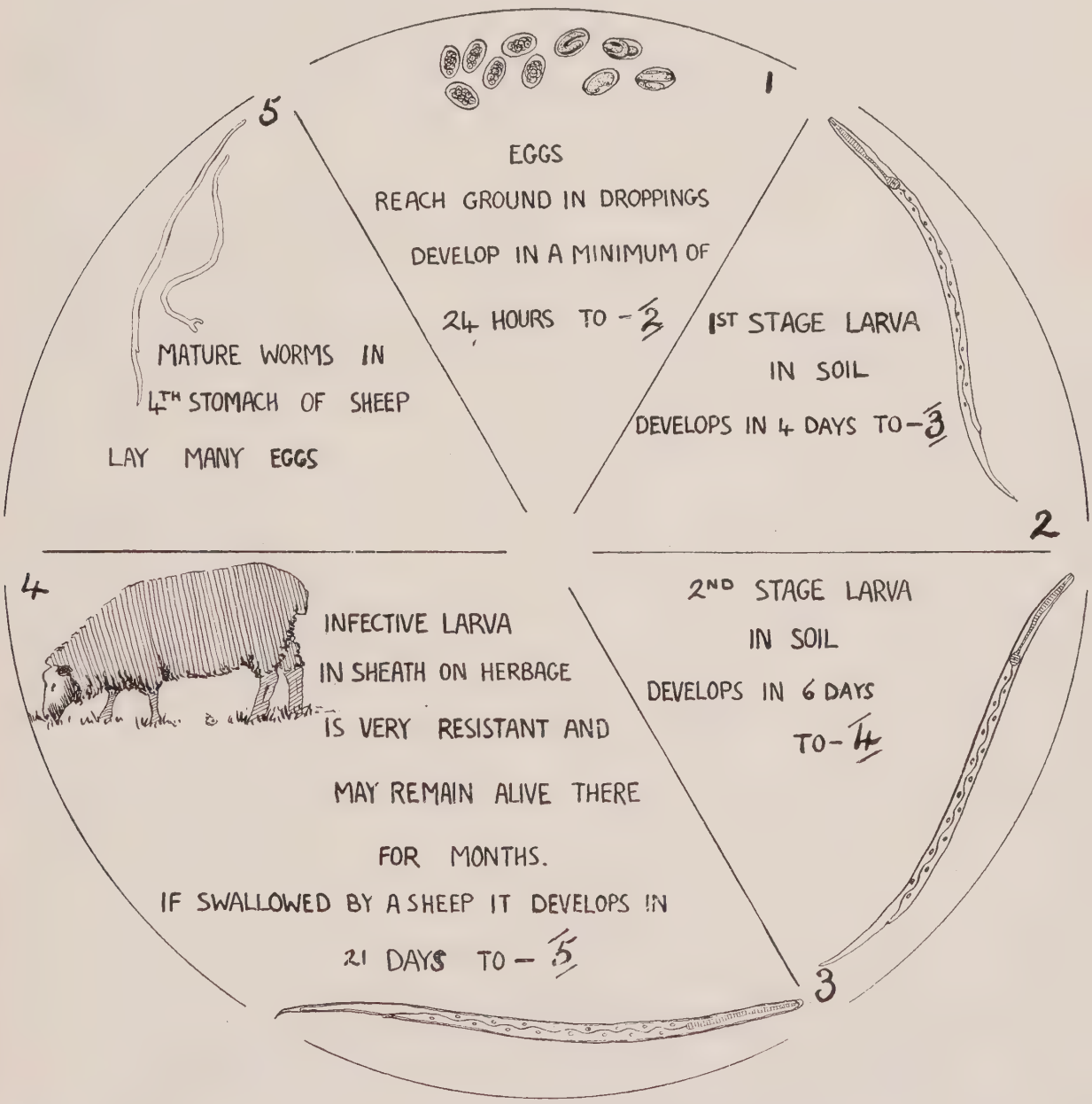

FIG. 16.—Life history of the stomach worm of sheep, showing various stages of its development, and the duration of each stage under favourable conditions on the ground. The eggs and larvae, being scarcely visible to the naked eye, have been greatly magnified.

[To face page 108.

FIG. 17.
Eggs of *H. Lineata.*

FIG. 18.—Full fed Larvæ of Warble Flies.

FIG. 19.—Puparia of Warble Flies.

FIG. 20.—Underside of a Piece of Skin showing Warble Fly Larvæ.

In their situation in the fourth stomach, the female worms lay large numbers of eggs which reach the ground with the droppings. Under favourable conditions of moisture and temperature on the ground, a minute larval worm develops in the egg, which may hatch within 24 hours from the time it leaves the sheep. The young worm now passes through two stages, from neither of which, however, can it continue its development if swallowed by a sheep. It must complete these stages and reach the third, or " infective larval stage," on the ground, before it is capable of growing to maturity when swallowed. The time taken by the larval worms in passing through the first and second stage to reach the infective stage may vary between three days and several weeks, depending upon conditions of moisture and temperature, dryness and cold delaying their development. Although in this country development would rarely be delayed because of excessive dryness, the temperature is usually well below that best suited to the larvae and it can only be in our warmest weather that they reach the infective stage in less than 7 days. This period is of some importance for control measures.

The infective larva is peculiar in being enclosed in two skins, its own and that which it wore during the second larval stage. This loose sheath acts as a protecting covering, and renders the larva very resistant to extremes of cold and dryness, or such chemical substances as lime and salt. Another, and most unfortunate, attribute of this infective larva is its ability to remain alive for a long period in a field, and although the majority die if they are not eaten by sheep within 12 months, some few may remain alive even longer. This larva is also able to travel in the moisture of the soil, and after having been buried to a depth of six inches may, under favourable conditions, regain the surface in as short a time as seven days, so that turning in the contaminated surface with the plough cannot be relied on as a means of prevention. The same power of movement enables the larva to climb on to the herbage in the dew or rain on its surface, where the larva lies in wait to be taken in by the grazing sheep. When this happens the protecting sheath is quickly lost, and the young worm passes through the third and fourth larval stages in the fourth stomach before finally developing into the mature worm. The time which elapses between the swallowing of the infective larval worm by the sheep and the appearance of eggs of the matured worm in the sheep's droppings is three weeks. The quickest possible time, therefore, for the completion of the life cycle is three weeks and three days, but as the rate of development on

the ground may be greatly retarded by unfavourable weather conditions, and the infective larva may rest on the grass for months before it is swallowed by a sheep, the cycle usually takes much longer (*see* Fig. 16).

Prevention and Treatment.—Where outbreaks occur, it is important to know which of the two worms here mentioned is responsible, since there is a satisfactory medicinal treatment for the twisted wireworm, while the lesser stomach worm does not respond to any treatment yet known. For this reason, and also because the condition may be confused with "liver rot," it is always desirable to call in the assistance of a veterinary surgeon.

In South Africa the twisted wireworm is an even more serious menace to sheep-rearing than in this country, and a mixture of copper sulphate (bluestone) and arsenious acid (white arsenic) has been used with great success as a cure and control. Copper sulphate is much the more active of the two ingredients and may be used alone, as advocated in America and successfully employed in this country. As the efficiency of the dose is only slightly increased by the addition of arsenic acid, it is advisable to leave such a dangerously poisonous substance to skilled and practised hands.

Copper Sulphate Treatment for Twisted Wireworm.—The treatment with copper sulphate is as follows:—

A solution of pure copper sulphate (bluestone) is made up by dissolving 4 oz. of the pure crystals (which should be of a clear blue colour with no white parts) in $2\frac{1}{2}$ gallons of water in a porcelain or enamel container. This will be sufficient for 100 sheep, and should be given in the following doses:—

Adults, according to size	... ...	3-4 fluid ounces
Lambs, 6-10 months' old	... ...	2-3 ,, ,,
Lambs, 4-6 months' old	... ...	$1\frac{1}{2}$-2 ,, ,,
Lambs, 2-4 months' old	... ...	1-$1\frac{1}{2}$,, ,,

The preparation of the solution may be hastened by dissolving the bluestone in a little hot water and bringing the quantity up to $2\frac{1}{2}$ gallons afterwards. The best way to administer the dose is by means of a metal funnel leading through a joining portion of rubber tube to a short metal tube; the sheep is held in a standing position with the metal tube in its mouth by one man, while another holds the funnel and slowly pours in the measured dose. Some little danger attaches to this proceeding if carelessly done, through overdosing or the passing of the the solution into the lung, and it is more satisfactory to have proper veterinary supervision at hand.

A fast of 12 hours before dosing, and of five hours afterwards, renders the treatment much more effective, but this measure is not altogether necessary and, if the sheep are already in a weak condition, may not be desirable.

If sheep are thriving badly, and some of the lambs are beginning to show signs of diarrhœa and becoming very weak, it is advisable not to wait for one to die, but to kill the weakest in order to make an examination of the fourth stomach, or have an examination carried out by a veterinary surgeon, as the worms may not be easily recognized. As soon as the cause of the disease has been ascertained through the discovery of the worms, the whole flock should be treated with a solution of bluestone as above described. Farmers whose sheep are frequently troubled with twisted wireworm should not wait for symptoms of the disease to appear, but should dose all the sheep in the spring, and continue with regular dosing at intervals of three or four weeks throughout the summer. Ewes which are heavily in lamb and lambs less than two months' old should not be treated. It rarely happens that the sheep are particularly sensitive to the poisonous properties of copper sulphate, and to avoid any considerable loss from the treatment of a large number of susceptible sheep it is advisable, where copper sulphate is not regularly employed, to dose a small representative portion of the flock before proceeding with wholesale treatment.

Control of Lesser Stomach Worm.—Where the disease is due to the lesser stomach worm, control must depend solely upon the arrangement of grazing in such a manner that the opportunity for lambs to pick up infection is reduced to a minimum. The parasitic worms of the fourth stomach of sheep are so common that they are regarded as almost normal inhabitants, and it is only when conditions are greatly in their favour that they occur in such large numbers as to do harm; a little weight thrown into the balance for or against the worms may decide whether they will become very numerous and get the upper hand, or whether the lambs will come through the summer unharmed.

Penning on Root or Forage Crops.—The arable farmer who pens his ewes and lambs on roots or vetches has the complete control of this disease in his own hands. There are certain bad systems of penning (generally followed in many parts of the country) which should at all times be avoided. These have the common fault of allowing the sheep to wander on to parts of the field that were grazed one, two or three weeks previously. During the intervening time the larval worms have reached

the infected stage and swarmed on to the young herbage, which springs up in the wake of the pen, and in grazing this the lambs may become very heavily infected. The best system of penning is the travelling pen, which provides for the removal of the sheep on to fresh ground every day, or every other day, and prevents their access to any ground that was grazed more than three days previously. It will readily be understood from the short account of the life history given above that under the last-mentioned system lambs could not possibly become infected, even though penned with heavily infected ewes, since two days is not sufficient time for the eggs dropped by the ewes to have reached a stage in which sheep can be infected. Nevertheless, this system of penning does not prevent the occurence of severe outbreaks, which may always be traced to the penning of sheep over the same ground within the previous 12 months. The minute larval worms from the previous folding have reached the infective stage and have not been left long enough to die of starvation.

Outbreaks of disease do not always occur when this practice is followed,because conditions of temperature and moisture may not have been the best possible for the development of the larval worms on the ground. If, however, land on which sheep are penned for one or two days at a time could afterwards be kept free from sheep for a period of at least 12 months the disease could not occur. The final outbreak is produced in the following way: sheep which carry a few worms are penned over a field and pass thousands of eggs on to the ground with their droppings. If sheep are penned over this same ground again within 12 months they will pick up thousands of infective larvae which will mature, and tens of thousands of eggs will be passed with the sheep's droppings. There may or may not be a sufficiently large number of worms present at this stage to cause serious disease, but if sheep go over that same ground a third time after an interval of less than twelve months, and if the conditions of moisture and temperature have been suitable for larval development, hundreds of thousands of infective larvae will be picked up and the sheep will suffer from parasitic gastritis.

This kind of outbreak occurs in parts of the country where the Wiltshire rotation or some modification of that rotation such as the following is practised: *Rye, Winter Barley* or *Vetches* grazed off by sheep in May, June and July is followed by *rape** and/or *turnips*. If this crop is planted early enough

* Rape here refers to the dwarf kind, which in some parts of the country is sown along with quickly maturing turnips. Giant rape is usually sown alone as a main fallow crop or as a catch crop, but some authorities recommend it mixed with turnips.

it may be grazed off during the same year; if not it is grazed off during the early spring of the following year and another crop of *rape* and/or *turnips* is put in during May or early June. This crop is grazed off in the summer or autumn and is followed by *wheat*. After the wheat comes another *straw crop*, then *clover*, and finally a *straw crop* to complete the rotation.

Under this system of cropping the sheep are penned over the same ground twice in a period of six months, and three times in little more than 12 months. In the crowded conditions of a pen of sheep on a green crop the mixture of droppings and moist earth resulting from the thorough trampling forms an ideal place for the young stomach worms to develop. If this system of frequent penning is continued, stomach worm trouble is almost certain to arise at a time when the sum total of conditions in favour of the worms happens to be just a little better than usual. Wherever possible, and particularly where such outbreaks have occurred before, it would be advisable to make such alterations in the system of farming as will ensure an interval of at least 12 months between two pennings of sheep over the same ground.

Although this may necessitate a little reduction in the number of sheep kept it would be worth consideration where the risk of parasitic gastritis in the sheep is great.

The disease could be controlled with certainty by some such modification of the old five-course rotation as the following: (1) *Roots*, (2) *Straw crop*, (3) "*Seeds*" or *Sainfoin* (cut for hay), (4) "*Seeds*" or *Sainfoin* (grazed), (5) *Straw crop*, (6) *Straw crop*, (7) *Roots* or *Green Forage*, (8) *Straw crop*. Sheep would then only go over the land on the first, fourth, and seventh years and the stomach worms could not possibly get the upper hand under such conditions.

Prevention of Straying of Lambs.—Another source of infection in lambs on arable land may be mentioned. The hurdles used for the pens sometimes allow exit to lambs, which are then able to graze the young herbage springing up on ground occupied by the flock some days or weeks previously—so losing the benefits of the good system of penning that may have been employed.

Control on Grassland.—Control on grassland is not so easy a matter to prescribe for, and must depend upon careful management of the grazing, particularly where the pasture is rich and will carry as many as four or five sheep to the acre. Every effort should be made to avoid overcrowding, to which end supplementary forage crops for ewes and lambs are useful

during the summer. These are, at the same time, a means for the provision of clean ground for the lambs. Where forage crops are not practicable, an attempt should always be made to reserve some clean pasture for the ewes and lambs, and to put them on ground where there have been no sheep for a period of 12 months.

Special care should be observed when, through drought, or for some other reason, there is a shortage of grass. Being forced to graze more closely on bare pasture, sheep take in more infective material at every bite, because the larvæ are concentrated at the base of the grass tufts. Furthermore, in order to find enough for a good feed under conditions of bare pasture, each sheep must graze over a wider area; so that, for two reasons, a larger number of infective larvæ are taken in during shortage of grass.

A liberal allowance of concentrated food should always be given where there is any danger of the disease, but it is particularly indicated for sheep on bare pasture: not only does it keep the lambs in strong growing condition and so render them better able to resist the disease, but also, in complementing the poor grass feed, it discourages the sheep from grazing over a large area of the field in which they happen to be, and for a prolonged period each day lessens the amount of infected material that they eat.

Summary of Important Points.—(1) Stomach worms are exceedingly common in sheep, but they cause harm only when present in large numbers.

(2) Overcrowding shortens the life cycle, as the young worm in the soil has a better chance of a speedy return to the sheep. A little better spacing of the sheep may make all the difference.

(3) Worms do not multiply in the sheep or lambs; every worm present in them must have been picked off the ground with the herbage.

(4) One sheep cannot be infected from the droppings of another until such droppings have been on the ground for a time, rarely less than 7 days, and usually longer. Hence infection picked up by lambs penned for two days at a time over different parts of a root field must have come from a previous grazing.

(5) Penning sheep over arable land twice in 12 months is dangerous, and many larval worms may be ready to infect the second lot of sheep. Penning over the same ground a third time after too short an interval is still more dangerous,

and if conditions happen to have been favourable for the development of the larvae, severe disease is likely to result.

(6) The young worms on the ground are very resistant to lime, salt, poisonous chemical substances (such as bluestone or green vitriol) and adverse weather conditions.

(7) The young worms may remain alive on the ground for a long period, but the great majority will have died in a field kept free from sheep for 12 months.

(8) Sheep parasitized by the twisted wireworm derive considerable benefit from treatment with bluestone as directed. This treatment has no effect upon the lesser stomach worm.

Summary of Preventive Measures.—(1) Overcrowding should be avoided, ewes and lambs should be placed on pasture which has been free from sheep for 12 months.

(2) A root or forage crop should be grown on clean land for the ewes and lambs to graze in the summer.

(3) Penning on arable land should be so arranged that the sheep have no access to ground over which they grazed more than four or five days previously.

(4) Where the penning of sheep on root and forage crops is largely practised, running them over the same ground twice within 12 months should be avoided.

(5) If sheep must be penned over the same ground twice within 12 months, the second crop should be eaten off by old sheep only, because of their greater resistance, the ewes and lambs being put on to clean ground.

(6) When sheep are penned on arable land, wire netting, or hurdles of such a pattern as will prevent the lambs from straying back to contaminated ground, should be used.

(7) If sheep are known to be affected with the twisted wireworm they should be treated with copper sulphate; and on farms where disease frequently occurs because of this parasite, treatment should be given at intervals of three or four weeks during the spring and summer.

STURDY OR GID IN SHEEP

The disease, known commonly under the names of sturdy, gid, turn-sick, etc., is caused by a cyst, or little bladder, called *Coenurus cerebralis,* which develops in the nerve centres and more particularly in the brain.

The animals which most frequently suffer from it are lambs and shearlings; it is rarer in sheep over two years of age. The disease occurs occasionally in goats, oxen, and other ruminating animals. It is very rarely found in horses. The

disease is, however, spread by other animals than these. The tapeworm, which lives in the small intestine of a dog, and is by no means uncommon in sheep dogs and sporting dogs, is the real source of infection.

The tapeworm is made up of a square-shaped head, with a long thin neck and a number of segments. These segments contain eggs, and when ripe they drop off. They are easily seen with the naked eye, being about half an inch long and one-fifth of an inch wide. They may go on increasing in number till the tapeworm is quite 40 inches long. They fall off as they become ripe, and are passed through the bowel of the dog to the ground, and it may be on to the pastures where the sheep are feeding. The segments then decay, and the rain washes the eggs over the grass or into ditches or pools from which animals drink. These eggs die if they cannot get moisture. It is known that a fortnight's exposure in warm dry air will destroy them entirely, whereas even after three months' exposure on damp grass the eggs remain alive, and lambs pastured thereon have caught the disease by browsing the infected grass. This is one reason why sturdy or gid is more common in flocks which feed on damp pastures, especially when the spring and summer have been rainy, but it should be understood that moisture only acts by favouring the preservation of the eggs.

If swallowed by a sheep the eggs hatch out embryos with six hooks, which bore their way through the wall of the stomach or intestines and enter a blood vessel. They are eventually carried in the blood to the brain, spinal cord, and other parts of the body, but only in the two former do they develop into fully-formed cysts or bladders. These cysts gradually increase in size and bring about the symptoms by which the disease is usually recognized.

The cyst, which is the sole cause of " gid," is a little bag of variable size, and though originally very small, may in two or three months become as big as a hen's egg. Its outer coating is very thin, and it is more or less expanded by a clear colourless liquid. The parent cyst develops on its surface 100 to 200 little chambers like white spots about the size of a millet seed, and each contains the head of a future tapeworm. They cannot develop further till the sheep dies, and the brain or the part containing the cyst is eaten by a dog. When this happens each little worm-head is set free from the cyst by the digestive juices. It becomes fixed to the wall of the intestine, and grows for about $2\frac{1}{2}$ months, when the segments are passed out on to the grass in the manner which has already been described.

Symptoms.—A sheep affected with gid may be excitable, and very timid when approached, or it may be dull and stupid. Usually it is seen apart from the rest of the flock walking about unsteadily. Frequently it turns round in a circle. It is seldom at rest for any length of time and if disturbed may try to run away, but it can only move helplessly round in one direction, often with its head carried unevenly on one side. In advanced cases the sheep may become blind.

If the cyst exists in the usual place near the surface of the brain and on one side, the animal usually walks round to that side; if a cyst exists on both sides the sheep may circle to one side or the other at different times; if the cyst be situated in the fore part of the brain, the sheep raises its nose and walks straight forward, only stopping as a rule when it knocks up against something; whilst if the cyst is lodged in the back of the brain, the head is raised and the sheep stumbles forwards with a jerking uncertain motion of its limbs, breaking into a sort of shambling run ending in a fall and a violent struggle to get up. If there are several cysts in various parts, the abnormal movements vary.

In the course of time the affected sheep refuses to eat, and by the combined effects of starvation and almost constant movement it rapidly wastes away and dies. The sheep may live for about six weeks after the appearance of well-marked symptoms.

The cyst may be lodged in the spinal cord, usually at the region of the loins. In this case weakness and dropping of the loins is noticed. Eventually the sheep becomes completely paralysed in its hind quarters, which it cannot raise from the ground. In such cases the animal may live for months.

Preventive Treatment.—1. More dogs than are necessary to tend the flock should not be kept. In the springtime of each year, the dogs should be tied up for a few days and treated for worms. The object of tying them up is to see if any tapeworms are passed; if so, the droppings containing the worms should be collected and burnt.

2. The heads of sheep which have been affected with " gid " should be burnt or boiled, and never left raw for dogs to eat.

Curative Treatment.—In consequence of the serious nature of the disease, and the frequently unsatisfactory results of treatment, nothing is, as a rule, attempted in the way of a cure, and affected animals are generally sent to the butcher. This is the least expensive course to adopt and usually the most satisfactory. It should be done as soon as distinct symptoms of gid appear, and the butcher should be warned to destroy the heads.

In exceptional circumstances, however, as when the sheep is of considerable individual value, operative treatment may be attempted. The operation consists in piercing the skull, and puncturing the bladder. It is desirable to remove the contents of the bladder, and as much of the latter as possible. Although the operation is sometimes performed with considerable success by intelligent farmers and shepherds, it is, on the whole, of such a delicate nature as to demand the services of a veterinary surgeon.

SWINE ERYSIPELAS

Swine erysipelas is a contagious febrile disease of swine caused by the bacillus of swine erysipelas.

Infection.—The pig is the only domestic animal that contracts the disease naturally, although certain other animals and birds can be infected artificially. Human beings are liable to become affected. The usual way in which pigs contract the disease is by taking food or water that has become contaminated with the bacilli; occasionally the bacilli may gain entrance to the pig's system through wounds or abrasions, and thus set up the disease. The bacilli multiply rapidly in diseased pigs, and are discharged in large numbers in dung and urine. The disease may thus be spread from affected to healthy pigs.

The bacillus of swine erysipelas can also carry on an independent existence outside the bodies of animals, and may survive in soil for a long time. Outbreaks of the disease may therefore arise from soil infection, quite independent of recent purchases of, or contact with, affected pigs, and in this country outbreaks originate mostly in this way.

The principal factor in maintaining infection on a farm is probably the use of contaminated manure. Its restriction to arable land does not entirely eliminate risk, since pigs may be exposed to infection if allowed access to such land after harvest, or if fed on roots produced thereon to which a certain amount of soil always adheres.

Prevalence.—Swine erysipelas is not a scheduled disease under the Diseases of Animals Acts, and is not notifiable; consequently, there are no complete statistical records available to indicate its prevalence or distribution. Some 1,200 outbreaks, however, are brought to light annually in the course of investigations into reported cases of suspected swine fever, and it is thus known that swine erysipelas exists in all parts of Great Britain and throughout the year, with a marked increase in the frequency and severity of attacks in the summer months. Outbreaks of

this disease occur mostly among fat pigs, that is to say, pigs at a somewhat more mature age than that at which they are usually attacked by swine fever.

Symptoms.—The first indication of disease may appear as early as 24 hours after natural infection, but an interval of 3 to 5 days is more usual. The clinical signs vary in intensity, but in general three readily distinguishable forms of the disease are recognized:—

(1) *Mild Cases.—Urticaria or Nettle Rash (Diamond-skin Disease).*—The pigs appear to be out of sorts and dull. Their appetite is impaired, and there may be constipation and thirst. A characteristic skin eruption develops on various parts of the body, especially on the chest, back, neck and the outside of the thighs. The skin in these places is discoloured dark red or violet in sharply defined areas, which are sometimes circular but more frequently quadrangular in shape, and which measure about 1-2 in. across. Usually the symptoms subside after the development of the skin eruption, and recovery takes place in a week or 10 days. Sometimes, however, the skin eruption takes a more serious course, resulting in the shedding of areas of skin, and sometimes the loss of extremities such as ears or tail.

(2) *Acute Cases.*—The animals show the usual signs of severe illness in the pig, namely, rise of temperature, shivering, loss of appetite, vomiting, and at first constipation, followed by diarrhoea. They lie in a state of exhaustion, or crawl under the straw in the sty. Death may occur suddenly within 24 hours, but usually the course of the disease is slower, and a red patchy diffused discoloration appears on the skin of the buttocks, thighs, body and ears. As, however, this discoloration may be found in other diseases of the pig, notably swine fever, it cannot be taken as a sure indication of the presence of swine erysipelas. The breathing is very rapid, and the pigs sway and stagger when made to walk. Ultimately, in fatal cases, the temperature drops suddenly, and the animals die in a state of coma within 3 or 4 days.

(3) *Chronic Cases.*—Swine that have passed through an acute attack may recover, but usually recovery is slow, and the animals remain unthrifty for a considerable time. In certain cases lameness caused by inflammatory changes in the joints of the legs is a very marked sequel.

Sudden death from heart disease frequently results in pigs that have passed through an acute attack but this is sometimes found also as a sequel to the mild form of the disease.

Post Mortem Appearances.—*In acute cases* the internal lining of the stomach and bowels is inflamed, and the glands in this lining are red and enlarged. Sometimes the surface over these glands is abraded, but the distinct ulcer of swine fever is not present. The lymphatic glands throughout the body are swollen and dark red in colour, and the spleen is often enlarged. The lungs are congested, and the membranous coverings of the lungs and heart show small red spots. Fluid may be present in the chest cavity and heart sac.

In chronic cases the tissues around the opening between the chambers of the heart, particularly on the left side, are frequently thickened and roughened and sometimes assume a warty or cauliflower-like appearance.

Prevention, Remedies and Sanitary Measures.—Newly purchased pigs should be isolated for a few days; this is particularly desirable with large fatting pigs bought during the summer months when the disease is most prevalent.

The carcasses of pigs that have died of swine erysipelas should be buried in lime. The litter and manure from styes in which affected pigs have been housed, and the walls, floors, and all feeding troughs and utensils should be thoroughly disinfected. Where pigs are kept in styes it is a simple matter to disinfect the manure with a suitable disinfectant liberally applied. Copper sulphate in a dilution of 1 per cent., or a disinfectant approved for use under the Diseases of Animals Acts is suitable. The treatment of large quantities of manure in yards is a more difficult problem. Putrefaction alone will not destroy the bacilli, and it will, therefore, be advisable to bury the manure under a layer of lime in a trench.

The administration of drugs either for the prevention or cure of this disease has no specific effect. A specific serum, however, is available for the preventive or curative treatment of pigs by inoculation. This serum is obtained from the blood of horses that have been injected with large numbers of swine erysipelas bacilli. Its use on pigs confers an immunity that begins immediately, but that lasts only for about 10 days. The simultaneous inoculation of serum combined with a properly adjusted dose of swine erysipelas bacilli (vaccination) confers an immunity that lasts much longer, probably for 5 or 6 months. The employment of this method, however, is not advised on non-infected farms because the operation might possibly infect the premises. This objection does not apply to the use of serum alone. An exception to this may, however, be made in the case of a clean farm in a locality where the disease is rapidly spreading. If

rigorous isolation is impossible, vaccination may be preferable to the risk of a natural outbreak, which would necessarily mean heavier infection of the premises.

Treatment of Diseased Pigs.—The only treatment of any value is by inoculation of serum alone. The serum is curative if used in larger doses than those employed as a preventive, and results of treating affected pigs by this method in different parts of Europe show that from 75 to 90 per cent. of pigs so treated recover; it may, however, be necessary to repeat the treatment. Recovery from a natural attack, whether the pigs have been treated with serum or not, will confer a prolonged immunity against re-infection. The attack, however, is liable to result in the setting up of disease of the heart, which at a later stage may cause death.

Treatment of a Herd in which Disease has Broken Out.—To control the spread of disease, all pigs that have been exposed to infection should be treated with serum alone. A fortnight later, pigs that have not shown any signs of illness should be vaccinated (by simultaneous inoculation of serum and bacilli) in order to give them a lasting immunity. Recovered pigs need not be vaccinated, since, as explained above, they already possess this immunity. Vaccination is deferred for a fortnight to avoid the administration of bacilli to pigs that have contracted infection, but in which the signs of disease are not yet apparent. In such cases vaccination would probably prove fatal.

During the course of an outbreak, all sanitary measures should be observed as set out above. To limit the area of infection, all ailing pigs, and those that have been in contact with them, should be isolated in styes. No new pigs should be brought to the premises, nor should any pigs be sent away, except for immediate slaughter under the strictest precautions against the spread of disease.

The selection of pigs for slaughter, particularly at the beginning of an outbreak, should be carried out with care and discretion, in order to detect any pig in the earliest stage of the disease. Such a pig on its general appearance may be deemed fit for slaughter, but in the process of dressing the carcass, discoloration of the skin may appear, and cause the carcass to be condemned as unfit for food. This post-mortem discoloration is more likely to be found in the coloured breeds of pigs, as the earliest signs of discoloration may be masked in life and may thus more easily escape observation. The treatment of a pig with serum does not affect its carcass value.

Protective Vaccination on infected Farms.—On farms where the disease has regularly or frequently broken out it is advisable

to consider whether vaccination should be adopted annually. As the recurrence of disease on an infected farm varies considerably both in frequency and severity, an owner must be guided by his past experience when making this decision. The following facts will be of assistance in this connexion:—

(*a*) Very little risk attaches to the vaccination of healthy pigs on infected premises, although occasionally it produces a transient nettle rash.

(*b*) This course is cheaper than the treatment of affected pigs, as the latter requires much more serum.

(*c*) It is obvious that a disease that usually attacks pigs when they are almost ready for slaughter must involve considerable financial loss through deterioration in condition, even if mortality is low. Vaccination will avert such a loss if it is carried out before the season of greatest activity of the disease and about 3 months before the pigs are expected to be ready for market.

(*d*) The usual method of vaccination is the simultaneous inoculation of serum and bacilli as already explained. If it is desired to prolong the period of immunity beyond 5 or 6 months, this can be secured by the inoculation of a dose of bacilli alone about 14 days after the first vaccination.

(*e*) The practice of annual vaccination has been carried out in this country by some farmers whose herds had previously been subject to recurrent outbreaks, and results have proved satisfactory.

NOTE.—In cases where disease amongst pigs has been reported as suspected swine fever, and it is found on investigation that swine fever is not present, the Veterinary Inspector will inform the owner if swine erysipelas is found. If the diagnosis is indefinite, material will be sent to the Ministry's Laboratory for examination and test. As soon as a definite diagnosis is established, the owner will be informed by telegram in order that, if he so desires, he may consult his Veterinary Surgeon as to the measures he should adopt to control the disease.

Supplies of serum and cultures of bacilli are constantly available in this country for use in outbreaks of swine erysipelas, and they may be obtained from wholesale firms at a few hours' notice. The bacilli in the cultures have not been killed, and great care must, therefore, be exercised in handling the material and measuring the dose. The administration of these products should, therefore, be confined to Veterinary Surgeons.

SWINE FEVER

Swine fever is a contagious disease. It is caused by a living and infective agent which is so small that it cannot be seen by the highest powers of the microscope. That it is a living agent is proved by the fact that if liquid containing infective material be passed through a fine bacteriological filter a very small amount of the filtrate will produce the disease in a pig

into which it has been injected, and the infecting agent will increase in its system to such a degree as to provide enough material to infect an infinite number of other pigs.

Animals which suffer from the Disease.—The pig is the only animal which suffers from swine fever, but within certain limits, which are not very wide, some pigs are more resistant to infection than others. As a general rule it may be said that young swine are less resistant than older animals, and that they suffer more severely when attacked by the disease. It must not be assumed, however, that older pigs do not take swine fever. They very frequently do, and in some outbreaks the mortality amongst the breeding stock is nearly as high as in the young pigs.

Incubation Period.—In every contagious disease there is an interval between the time of infection and the appearance of the symptoms of the disease; this is called the incubation period. During this period the infecting agent is growing in the system of the animal and producing poisonous substances and alterations of tissue, which eventually give rise to the symptoms. In swine fever the incubation period is usually about five days, but it should not be expected that in every case infected animals will be distinctly ill in this time. Some of them may not show outward symptoms until about ten days after infection, but, notwithstanding this, if their temperature be taken with a thermometer, it will be found to be higher than usual.

Symptoms.—The affected animals show marked want of appetite, and it is said that "they do not come up to the trough." They shiver, and bury themselves in the dry litter, or if there is no litter, they may lie up in one corner of the sty. Sometimes they vomit at the commencement of the disease. If the temperature be taken it will be found to register from 104° to 107° Fahrenheit. There may, or may not be, a purple rash on the skin of the ears, belly, and hock; diarrhoea is generally present. The animals gradually get weaker, and when made to move, they stagger about the sties in a drunken fashion; finally, they become unconscious, and die.

The duration of the disease varies considerably, but pigs seldom die under ten days after natural infection. More commonly they die from an acute attack of the disease after fifteen days. A considerable number, however, may live for thirty days, and in some cases pigs affected with swine fever may live as long as eighty days.

A noticeable symptom in the more chronic form of disease is great thirst, and the pigs may often be seen and heard sucking up the drainage from the floor of a wet sty. They are also inclined to eat all kinds of filth in preference to the ordinary food—generally displaying a morbid appetite. Another noticeable symptom of swine fever in the chronic form is swelling of the joints.

The symptoms vary in degree according to the activity of the infecting agent. In some outbreaks, for example, outward symptoms amount to very little more than an appearance of unthriftiness in a number of the pigs. The fact that deaths may not occur in such cases often misleads the owners regarding the true nature of the trouble, which may be hidden by symptoms of inflammation of the lungs (pneumonia) giving rise to breathlessness and panting. The appearance of pneumonia in several pigs may, in fact, be the first important indication of the existence of swine fever. In other cases pneumonia may attack, and carry off, animals which are recovering from mild attacks of swine fever. There is no disease of swine except swine fever in Great Britain, which as a general rule gives rise to so many deaths at short intervals, or to continued unthriftiness amongst a number of swine. Taking one outbreak with another the average death-rate is very high. It may even amount to 100 per cent. of the pigs on the premises.

Pig owners should suspect swine fever under the following circumstances:—(1) When a number of pigs are dying; (2) when a number of pigs are sick or unthrifty; (3) when periodic deaths are taking place, even if the other pigs appear healthy; (4) when large numbers of deaths are taking place in sucking or newly weaned pigs, even if the older ones appear to be healthy; (5) when a number of pigs are sick or dying with symptoms of inflammation of the lungs, diarrhoea or what may appear to be acute swine erysipelas ("Diamonds"); (6) the fact of suspicious symptoms appearing first in pigs which have been recently purchased, or in those which have been off the premises to a market, and have been brought back, should increase the suspicion. Careful inquiry, however, into the circumstances in connexion with a number of outbreaks shows that the fact of new pigs not having been brought on to the premises for some months does not of itself justify a definite opinion that an outbreak of disease is not swine fever.

Post-Mortem Appearances.—The carcasses of pigs which have died of swine fever may or may not be emaciated, and purple patches may be present on the skin of the ears, belly

and hocks. In the acute cases characterized by death after a short period of illness, redness of the lymphatic glands is observed, there are signs of inflammation on the inner lining (mucous membrane) of the intestines, while the membrane is often dotted over with innumerable small red blood spots. These spots (haemorrhages), however, are not peculiar to the very acute forms, but may also be seen in the more chronic cases. In the latter cases one finds a deposit in the form of a yellowish membrane on the inner surface of the intestines. The most typical lesion is the swine fever ulcer, which is most commonly found in the large bowel about the junction of the end of the small bowel (ileum), and blind gut (caecum), but swine fever ulcers may also be found much more rarely in the throat, on the tongue, and on the skin. In examining the intestines of sick animals which have been killed for purposes of diagnosis, it must be borne in mind that it does not follow that the disease is not swine fever because the typical ulceration and deposit are not found. The experimental inquiries conducted by the Ministry have shown that many animals may have a slight attack of swine fever and recover in a little more than ten days. If cases of this description be examined in the stage of fever, nothing more may be found in the bowels than slight redness or surface sores on the folds of the mucous membrane. The most common form of ulcer is about the size of a three-penny piece. Its edges are circular, and raised above the membrane. Its centre is soft and either yellow or black in colour. Congestion of the mucous membrane of the bowel should always be looked upon with suspicion, and particularly if it is combined with inflammatory symptoms in the lungs.

The Infective Material and how Infection Spreads.—The blood of pigs suffering from swine fever contains a large amount of the infective agent, and as the blood flows through all the organs and tissues, they also contain it. All the discharges contain the infective agent to a greater or less extent, and the intestines showing ulcers are particularly dangerous. Healthy pigs acquire the disease by mixing with affected pigs. The latter through their excretions infect the troughs or the ground and litter, and the healthy animals are infected by swallowing, or licking up, contaminated material. Infected material can be carried on the boots and clothes of attendants or castrators to neighbouring establishments, but it is mainly by affected, living pigs that the disease is spread from one part of the country to another. In this connexion what has already been indicated might

be repeated here with advantage:—(1) Unthrifty pigs may have swine fever without showing definite symptoms of the disease, and may be moved to other premises in the belief that they are suffering from some trifling and non-contagious disease; (2) some pigs may have apparently recovered from swine fever, although they are suffering from the disease in a very chronic form, and such pigs may be infective to others for a period of as long as eighty days or even more. In the majority of cases, however, such pigs show a certain amount of unthriftiness, and very frequently they are stunted.

Prevention.—It may be stated at the outset that the more sanitary the conditions of the premises the better will be the chance of preventing swine fever, once it is introduced, from spreading rapidly through the pigs in different sties. For those who buy pigs in markets, however, or who are dependent on other people in any way for their supplies, it must not be thought that the possession of sanitary premises is a safeguard against the introduction of the disease. Precautionary measures may be tabulated as follows:—

(1.)—Pigs which have been recently purchased, or which have been off the premises to a market and brought back again, should be kept isolated from the others for about a month, and carefully watched; the same rule applies to sows which have been to the boar and to pigs which have recently been cut by a practising castrator.

(2.)—In the event of suspicious symptoms of swine fever appearing in pigs on any part of the premises, pigs therein should, if possible, be kept rigidly isolated from the others, and have separate attendants who should wear special boots and overalls while going about the sties. If, however, the existence of disease is confirmed by the Ministry, and the owner agrees to adopt the serum treatment (*see* later), it may be considered advisable to mix the ailing pigs with the healthy after the latter have received a protective dose of serum.

(3.)—If there are rats on the premises, an effort should be made to reduce their number.* This is advisable not because rats suffer from swine fever, but because it is possible that they may convey infected material from one sty to another.

(4.)—Serum treatment is now known to be useful in saving the lives of pigs on infected premises, providing owners report

* *See* Advisory Leaflet No. 49, *The Destruction of Rats and Mice,* free and post free from the Ministry, *also* Bulletin No. 30, *Rats and How to Exterminate Them,* Price 6d. (7d. post free), obtainable from H.M. Stationery Office.

at an early stage, as its value in this connexion is limited to those pigs which are not infected with swine fever at the time treatment is applied. Treatment by serum is dealt with in a special Form—" ADVICE TO OWNERS OF INFECTED HERDS "—No. A21/T.A., which is obtainable from the Ministry, and veterinary inspectors of the Ministry when dealing with outbreaks have been instructed to supply owners with further information on the subject should it be required.

NOTE.—Swine fever is a disease scheduled under the Diseases of Animals Act, 1894, and the existence or suspected existence of the disease must be notified to the police in accordance with the provisions of the Swine Fever Order of 1908. Copies of this Order can be obtained free of charge on application to the Ministry.

TUBERCULOSIS IN FARM STOCK

Tuberculosis is a disease caused by a particular species of minute organism called the tubercle bacillus.

The disease is contagious. It has a very wide distribution and affects man and many different species of mammals and birds. The prevalence of tuberculosis amongst cattle is very great, particularly amongst dairy cows. Swine also are frequently attacked, and in them the disease is often of bovine origin; they become infected through eating the diseased organs of cattle or through being fed upon whole or skimmed milk from cows with tuberculous udders.

Of the other domesticated mammals, horses, cats and dogs are susceptible to tuberculosis, but very few cases have been recorded as occurring in sheep and goats.

The bacilli on entering the body may become established in various parts or organs and multiply there, causing alterations in the cells and destruction of tissue. Thus the characteristic nodules or tubercles are formed, and their presence interferes with the function of the part or organ. In addition to causing local effects, products of the bacilli are absorbed into the system and interfere with the general health of the animal.

In ordinary circumstances the tubercle bacilli do not multiply outside the animal body, but they are capable of living for some time; they are killed by exposure to disinfectants, to a suitable temperature, or to the action of direct sunshine. In a moist state, e.g., when suspended in milk, the bacilli are killed by boiling, or by exposure for half an hour to a temperature of 145-150° F. (pasteurization).

The Virulent Material and its Distribution.—The material excreted from diseased organs that have natural openings very frequently contain tubercle bacilli. The more actively the tuberculous degeneration is going on in the tissues, the more virulent are the discharges likely to be, but it must not be assumed that because the extent of the lesions is slight the discharges from the affected organ are not infective. Bacilli may be coughed up and voided in the mucus from an infected lung. They may be discharged from the intestine, if its inner coats are the site of tuberculous injuries, or the excretions from the healthy intestine may be virulent owing to infected mucus from the lungs having been swallowed. The milk from a tuberculous udder is often highly virulent and in some cases of the disease the milk may contain tubercle bacilli although the udder is not affected. When the uterus is tuberculous there is often an infective discharge from the external genital organs. The pus from tuberculous abcesses that sometimes involve superficial lymphatic glands and the skin is virulent. These are the principal methods by which the bacilli are excreted and distributed in the cowsheds, on the pastures, and in the drinking water. Generally the advanced cases (piners or wasters) provide by far the largest amount of virulent material.

Methods of Infection and Distribution in the Body.—Animals usually become infected with tuberculosis in one of two ways, viz., breathing or swallowing. It is also possible for infection to take place by inoculation through the skin, but this is not a common method of natural infection. In cattle the common method is by breathing air laden with tubercle bacilli, resulting in tuberculosis of the lungs and of the lymphatic glands connected with them.

The disease is usually of a chronic nature, and may for a long time be confined to small areas of the lungs. In some cases, however, the infected areas increase in size, until a large part of the lung becomes consolidated. From these areas the bacilli may be conveyed by the lymphatic vessels to the lining membrane of the chest and set up a tuberculous pleurisy. From the lung lesions the bacilli may also escape into the air passages, and pass to the throat, where some are coughed or snorted out into the air, but the majority are swallowed, and most of these reach the outer air with the fæces of the animal.

Some of the bacilli swallowed may be arrested in the intestinal wall, where they set up centres of disease; others pass through the wall, and are carried to the neighbouring lymphatic glands,

which become infected, and from which the disease may spread to the membrane surrounding the intestines and thence to the udder.

The disease may spread to the liver and kidneys, and, though rarely in cattle, to the spleen. In cows the uterus is not uncommonly affected in advanced cases. The lymphatic glands of the throat are sometimes affected.

An animal may become extensively affected without the bacilli passing into the blood stream. Occasionally they do gain access to the circulation, and are distributed with the blood over the whole body. The disease is then said to have become generalized, and the most constant result is the formation in the lungs of numerous small, grey or yellow, nodules up to the size of a hemp seed. (*Miliary* tuberculosis.)

Symptoms.—Symptoms during life are often not very distinct; frequently there is a chronic cough and troubled breathing, with more or less anæmia and wasting. Some diarrhœa is usually associated with abdominal lesions.

In many cases the disease runs a mild chronic course and the animals show hardly any signs, and the presence of the disease is then sought for by the aid of Tuberculin which may be applied in one or more of several ways.

A very important seat of the disease in cows is the udder, on account of the discharge of the bacilli with the milk, and the consequent danger of infection to man and milk-fed animals.

The hinder quarters of the udder are usually first affected and the disease may manifest itself in one or both of these quarters. There is a hard and painless swelling, growing slowly, but steadily. Sometimes it is somewhat irregular but often it is diffuse and very hard, and one or more quarters may be completely indurated. At first the milk is normal, but as the disease advances the milk of an affected quarter becomes thin and watery. Later it decreases in amount, and becomes flaked.

Preventive Measures.—Various eradication schemes have been put forward; most of them involve the periodical use of the Tuberculin Test followed by the isolation or destruction of reacting animals. If adopted generally, these plans would involve a huge expenditure, but it is beyond dispute that the disease has been eradicated from many herds by these methods, and sometimes with comparatively small expense.

Animals in an advanced stage of the disease, and particularly cows with tuberculous udders are chiefly responsible for the spread of infection amongst cattle and also from cattle to men.

These sources of infection can be removed on detection, and their removal involves merely the destruction of animals that are already either unprofitable or would soon become so.

The more animals are kept indoors and crowded in insanitary surroundings, the more likely is the disease to flourish, as, given the presence of a tuberculous animal, these conditions favour the spread of infection to the other animals. It must not be thought, however, that the disease can be eradicated from a herd by providing a generous allowance of cubic space, and freely ventilating the buildings; for tuberculosis has been known to spread alarmingly in excellent cowsheds, and even cattle at pasture run serious risks, if they are in association with badly infected cattle. These remarks are not intended to belittle the importance of allowing a reasonable amount of cubic space per animal in cowsheds, but to accentuate the importance of ridding a herd of infective animals. The danger of allowing calves to suck a cow with a suspicious udder, or one that is in the advanced stages of tuberculous is now obvious. The milk of such cows should not be used to nourish animals or man. The by-products from creameries, a fruitful source of infection in pigs, owe their dangerous quality mainly to the fact that they are the product of a very large number of cows, and the more cows contributing to the milk supply the greater will be the number supplying tuberculous milk. Creamery products, however, can be rendered harmless by pasteurization, or by bringing them to the boiling point.

Since tuberculous animals excrete virulent material, mainly from the lungs and the bowel, the need for frequent cleaning and disinfection of cowsheds, particularly the parts most liable to be contaminated by the mucus from the lungs and the fæces, is all the more pressing. In the moist state these virulent materials may directly contaminate food or water, but, if left to dry into dust, the dust may permeate the air of the cowshed and be inhaled by other animals in more distant contact, or contaminate their food. Common feeding or drinking troughs should not be used, especially in infected herds.

NOTE.—TUBERCULOSIS ORDER OF 1925.

Under the above Order, every person having in his possession or under his charge:—

(i) any cow which is, or appears to be, suffering from tuberculosis of the udder, indurated udder or other chronic disease of the udder; or

(ii) any bovine animal which is, or appears to be, suffering from tuberculous emaciation; or

(iii) any bovine animal which is suffering from a chronic cough and showing definite signs of tuberculosis shall, without avoidable delay, give information of the fact to a constable of the police force for the area wherein the animal is, or to an Inspector of the Local Authority.

The person in possession or having charge of such an animal is required forthwith to take such steps as are necessary to secure compliance with Article 10 (*Precautions to be adopted with respect to Milk, &c.*) and Article 11 (*Detention and Isolation of Suspected Animals*) of the Order.

THE WARBLE FLY

Every farmer is familiar with the barrel-shaped maggots that are often to be found in large numbers, from January until May, just under the skin on the backs of cattle. These maggots are the grubs of the warble fly. When present in large numbers they are the cause of enormous loss to farmers, much greater than is commonly realized. At a low estimate, the annual loss in damaged hides alone is put at upwards of £500,000; but this is not the only damage they do. The butcher often finds the flesh beneath the " warbled " areas so altered by the inflammation set up that the meat is useless for human food: this inflamed condition of the beef is termed " licked."

Although the maggots are the chief culprits, the adult flies are by no means free from blame. When flying round on the look out for a suitable place to lay their eggs, they frighten the cattle, which rush about the field with their tails in the air. This " gadding " often causes the animals to lose condition and decreases the yield of milk in cows.

The following account of the pest and methods of dealing with it is, unless otherwise stated, largely based on the work of Dr. Carpenter, Dr. MacDougall and of the Warble Fly Committee of the Ministry, which published its final report in July, 1926.

Kinds of Warble Flies.—There are two kinds of warble flies in this country; both are much like small bumble bees in appearance and fly in bright sunshine with a " hum," distinct but not loud. The larger warble fly known scientifically as *Hypoderma bovis*, and generally more common, has whitish hairs over the front of the body and lemon yellow hairs at the tail, while the smaller kind, *H. lineata*, has the front region largely bare of hairs and a bright orange tuft at the tail. The *H. lineata* appears on the wing a month earlier, on the average, than *H. bovis*.

Description and Life of the Pest.—The egg-laying season lasts from May until August. As may be seen from Fig. 17,

the eggs are of a rather curious shape. They are about one-twelfth of an inch long, and each one has a grooved base by which it is attached to the hair of the animal. The eggs are laid, chiefly on the legs, particularly the hind legs, of the animal attacked, and usually just below the heel joint or hock, more rarely on the flanks, and apparently never on the back. The larger fly, *H. bovis*, lays her eggs singly near the base of a hair, but the small one, *H. lineata,* places them in a row of seven or more half-way up a hair.

In four or five days the little maggots are hatched, and at once enter the skin close to where the eggs were laid. At this stage the maggot is only one-thirtieth of an inch long, but it has relatively very strong sharp jaws and spines. Having bored into the skin, the tiny maggots spend some time wandering through the system of the animal until they finally reach the wall of the gullet, in which they are found embedded from September to January. They are now in the second stage, somewhat narrow and cylindrical with feeble jaws and very few spines. After several months' residence in the gullet wall, the maggots continue their wanderings and begin to appear under the skin on the back of the animal, sometimes as early as November and December, but much more frequently from January and February onwards. Here they enter upon the third stage of their existence; they become larger, thicker, and more spiny. Each maggot lies in a small swelling, feeds on the fluid which arises from the animal's inflamed flesh, and breathes through a hole that is bored through the skin, and in this position it passes to the fourth stage of its existence.

In late winter or early spring, most of the maggots become fully grown (Fig. 18) and afterwards work their way out through the holes in the skin and fall to the ground. They have a large number of tiny sharp spines arranged in rows on their bodies, and these spines help their movements. Falling to the ground, the maggot undergoes a change, its outer coat becoming contracted, hard, firm, and dark in colour, to serve as the puparium or protective case within which transformation into the fly goes on (Fig. 19). For six weeks or so, the insect, now in its fifth or resting pupal stage, remains motionless among the grass, or under a stone or clod. The sixth and final stage is reached when the fly emerges after pushing off the front end of the puparium.

How to Destroy the Pest.—(1) There is no evidence that the various washes and smears commonly recommended for use in summer are of any great value in preventing flies from

laying their eggs on the cattle. Some protection may, however, be afforded by giving the cattle access to shade and water in which they can stand, and it is worth remembering that yearling and two-year-old bullocks and heifers are more subject to warble-fly attack than young calves, and calves more than milch cows.

(2) An effective method of exterminating the insects is to squeeze out and destroy the ripe maggots, beginning in February or March and continuing during April, May and June. Where several maggots are removed from a small area of skin, it is advisable to apply carbolic oil.

(3) Experiments made by the Committee of the Ministry previously referred to, and by workers in the U.S.A., indicate that dressings containing the active principles of Derris root are likely to prove very valuable in the destruction of warble larvae. These findings were confirmed by the demonstration experiments carried out in Worcestershire in 1929 by Dr. Walton and Mr. Gaut under the auspices of the Agricultural Education Sub-Committee of the County Council. In this demonstration, two Derris preparations were used, an ointment, and a wash prepared from a powder which is sold as an insecticide. The report, published by the Department of Agricultural Education, Shire Hall, Worcester, claims that both the ointment and the wash, when carefully applied, will kill practically all the mature or maturing warbles at a cost in materials of about one penny per head for the complete treatment (four applications). No harmful effects on the health of cattle after treatment are recorded in the report. In using the ointment, it is essential that each warble-hole should be separately located and treated after being reasonably freed from covering hairs. This is a laborious process, needing skill and care, especially if there is a heavy infestation. It can be employed for cattle which are tied up, but is probably impracticable in most cases where the cattle are in yards or fields. The wash can be applied much more readily by means of a soft cloth, and its use needs little skill; it is only necessary to ascertain the position of the swellings and then liberally wet each one.

Both the ointment and the powder from which the wash is prepared are proprietary articles, and there is not at present any non-proprietary standardized form of Derris root generally available on the market, but a number of firms supply Derris preparations.

The selected dressing should be used at intervals of two* to four weeks from the beginning of February until the end of June, according to the district concerned†: examinations of cattle should be continued until the end of the period, even if at an earlier stage no warbles have been observed, because there may be an interval between the appearance of the early maturing *H. lineata* and that of the later *H. bovis,* and continued regular inspection may disclose the presence of warbles of the latter at the end of the season: these, if not destroyed, would maintain infestation and nullify the earlier effort. It is only by perseverance and general effort that the numbers of the insects can be reduced, and several years' work will be needed to approach extermination of the fly.

The application of any preparation will not prevent the fly from striking; the sole object is to destroy the maturing warbles which have developed from eggs deposited during the previous season. Extensive application is unnecessary, and is, in fact, undesirable when tobacco powder or nicotine sulphate dressings are used, as cases have been reported to the Ministry where liberal application of the nicotine sulphate preparation has produced symptoms of poisoning. All the affected animals recovered after treatment. Possibly the cattle which became ill had licked the dressing from other treated animals, and steps should be taken, as far as is practicable, to guard against this risk, but they need not be maintained for more than a few hours, since the active principle is volatile and the poisonous character of the dressing will diminish as the mixture volatilizes.

An appeal is made to cattle owners in their own interests to kill as many warble maggots as they possibly can, and not only themselves to destroy the pests, but to persuade neighbouring farmers to do the same, for unless the practice is general over wide areas the results will be disappointing.

Farmers do not seem to realize that they are themselves bearing a high proportion of the immense loss occasioned by warbles, as they are every year getting lower prices for their cattle than they would command if warbles were exterminated or even greatly reduced in number. Warbles are certainly troublesome pests to deal with, but if all farmers

* In the case of the ointment.

† As a result of experiments carried out in Worcestershire in 1930, it is recommended that the dates of treatment in that part of the country should be about 17th March, 14th April, 12th May and 16th June: Report published by the Department of Agricultural Education, Shire Hall, Worcester.

would, for any two or three years take the necessary steps, there is no reason why the insects should not be almost exterminated. The higher prices which would then be obtained per beast would compensate many times over for the trouble taken in eradicating the pest.

PREVENTION OF WHITE SCOUR IN CALVES

In order successfully to combat the disease known as White Scour in calves, a disease which yearly claims a large number of victims, the following procedure should be fully and carefully observed:—

Disinfection of Premises.—The floors of cow-houses and calf-houses should be thoroughly cleaned and disinfected at least once each week with a solution of bluestone (*copper sulphate*), made by adding 2 lb. of bluestone to 3 gallons of water. The floor of the calf-house should be of concrete, and should be swept daily and disinfected with a solution of bluestone of the above strength.

Navel Treatment.—(*a*) When a cow is about to calve, she should be given a good bed of clean, fresh straw to keep the calf clean.

(*b*) When she shows signs of calving, her "bearings" should be washed with a warm $2\frac{1}{2}$ per cent. (minimum) solution of carbolic acid in rainwater, or an equivalent disinfectant. The carbolic acid should be not less than 95 per cent. pure. The solution, at half strength, should also be injected into the passage through which the calf is to be born.

(*c*) Immediately the calf is born, the navel cord should be tied with twine which must be kept ready in the carbolic acid solution. The person who ties the cord should first scrub and wash his hands with the solution.

(*d*) Immediately the cord is tied, the portion adhering to the calf, as well as the surrounding part of its body, should be carefully painted with a tincture of iodine or with *liquor iodi* (B.P.).

(*e*) After a few minutes the navel cord should be painted with a layer of collodion containing 1 per cent. of iodine, or with Stockholm tar.

General Recommendations.—1. Navel treatment without repeated and careful disinfection will NOT be successful.

2. Newly-born calves should be placed in a place that has been freshly disinfected. Carbolized sawdust will be found a useful litter.

3. Colostrum should not be withheld from the calves.

4. Healthy calves should not be housed or fed with those that are diseased.

5. Separated milk should not be given until the calf is four weeks old. The change from new to separated milk should be gradual. The calf should have a substitute for the cream removed by the separator. One to two oz. per day of the best cod-liver oil, or a mucilage prepared by steeping linseed or good linseed cake in hot water, will be found useful for this purpose. The quantity, however, should be carefully regulated in accordance with the state of the bowels.

For further hints on the management and feeding of calves reference should be made to Bulletin No. 10 on Calf Rearing, obtainable from H.M. Stationery Office, price 5d. (6d. post free).

WORM DISEASES OF PIGS

Two kinds of worms are of outstanding importance to British pig farmers, the large round-worm (*Ascaris lumbricoides*) of the intestines, and the thread-worms of the lung.

The Large Round-Worm of Pigs

Description.—The worm measures up to 12 in. and even more in length, and about $\frac{1}{4}$ in. in thickness; it is round, tapering towards either end, and is white in colour. It is very common in young pigs.

Damage Caused.—In its young stages this worm injures the lung by boring through its substance, and should many of the young worms be passing through the lung at one time a condition of congestion results, which may lead to pneumonia and death. During the congestion period the rapid breathing of the affected pig is often accompanied by a pulsating movement of the flanks; this condition is known as " thumps."

In the mature stages, the worm does damage in the intestine, the irritation that it causes interfering with digestion, while sometimes it enters the bile canals of the liver and causes an obstruction there; or it may be present in such large numbers as to block up the intestine completely.

Life-History.—This is complicated by a tour round the body, which the larvae makes before settling down in the bowel, and is most satisfactorily described by the aid of a diagram (Fig. 21).

1. The female worm situated in the small bowel lays over 200,000 eggs daily, and these reach the ground with the droppings.

2. The eggs cannot infect another pig until a small worm has developed inside them, in just the same way that a chick develops in a hen's egg. This development takes from four weeks to two months, or longer, according to the weather conditions.

3. The ripe egg (containing an infective larva) is swallowed by the pig and reaches the intestine, where the young worm hatches out.

4. The young worm bores through the bowel wall into a vein and is carried in the blood to the lungs.

5. The young worm bores out of the blood vessels in the lungs, enters the air passages, and climbs up the windpipe to the throat.

6. After this tour, which has taken about ten days, the young worm is swallowed a second time (having grown a little in the lung), and develops to a mature worm in the bowel; where in about ten weeks' time the female begins to lay large numbers of eggs.

Remarkable Vitality of the Eggs.—When preventive measures are considered, the vitality of the eggs of this worm is a most important point. These eggs are able to live for weeks in very strong solutions of disinfectants, in acids, or in lime; they can withstand great cold or a long period of dryness; and are capable of remaining alive for five years, and even longer. Although so long a retention of vitality may be unlikely under farming conditions, it is a possibility that ought not to be overlooked. These facts suggest that disinfectants and lime are of little value as a means of killing the eggs.

Prevention and Treatment.—Since older pigs suffer but little from these worms, efforts must be directed towards the protections of the young pigs from infection by ripe eggs in the soil, in sties, etc., and for this purpose two systems of rearing are suited.

I. *Extensive-System Rearing.*—This system is suited to mixed farms where plenty of land is available. It has been used with great success in America, the method employed there being as follows:—

Two or three weeks before farrowing-time a pen is prepared for the sow, and this should be more than ordinarily clean. After all the litter has been removed, the floor and walls should be scrubbed with *boiling water* and washing-soda. The soda will remove the dirt, and the heat of the water will kill the eggs, which may be there in large numbers. Before the sow is placed in this clean pen, she should be thoroughly washed with soap and water to remove all dirt and the eggs of worms, which are coated with a sticky substance and adhere to the skin. Particular attention should be paid to the underneath parts,

which are mouthed by the young pigs. The sow and her litter (when farrowed) should not be allowed out of this pen until they are all removed in a crate or cart to clean pasture; this may be done between one and two weeks after farrowing. The pasture to which they are taken should not have been used by pigs for three or four years previously. Land growing forage crops that becomes available during the normal course of rotation is very suitable, and on such ground the pigs can be left for at least four months, when they will have outgrown the period of greatest danger.

Where this system has been practised it is estimated that as many pigs can be raised from two sows as have previously been raised from three, and that they develop in a more rapid and uniform way.

II. *Intensive-System Rearing.*—The pig pens should be constructed of concrete with as few corners as possible. The cleaning of the farrowing-pen and of the sow before she is brought into it should be carried out with great care, as advised for the extensive system. Great care should also be taken to protect the young pigs from any contact with infective material

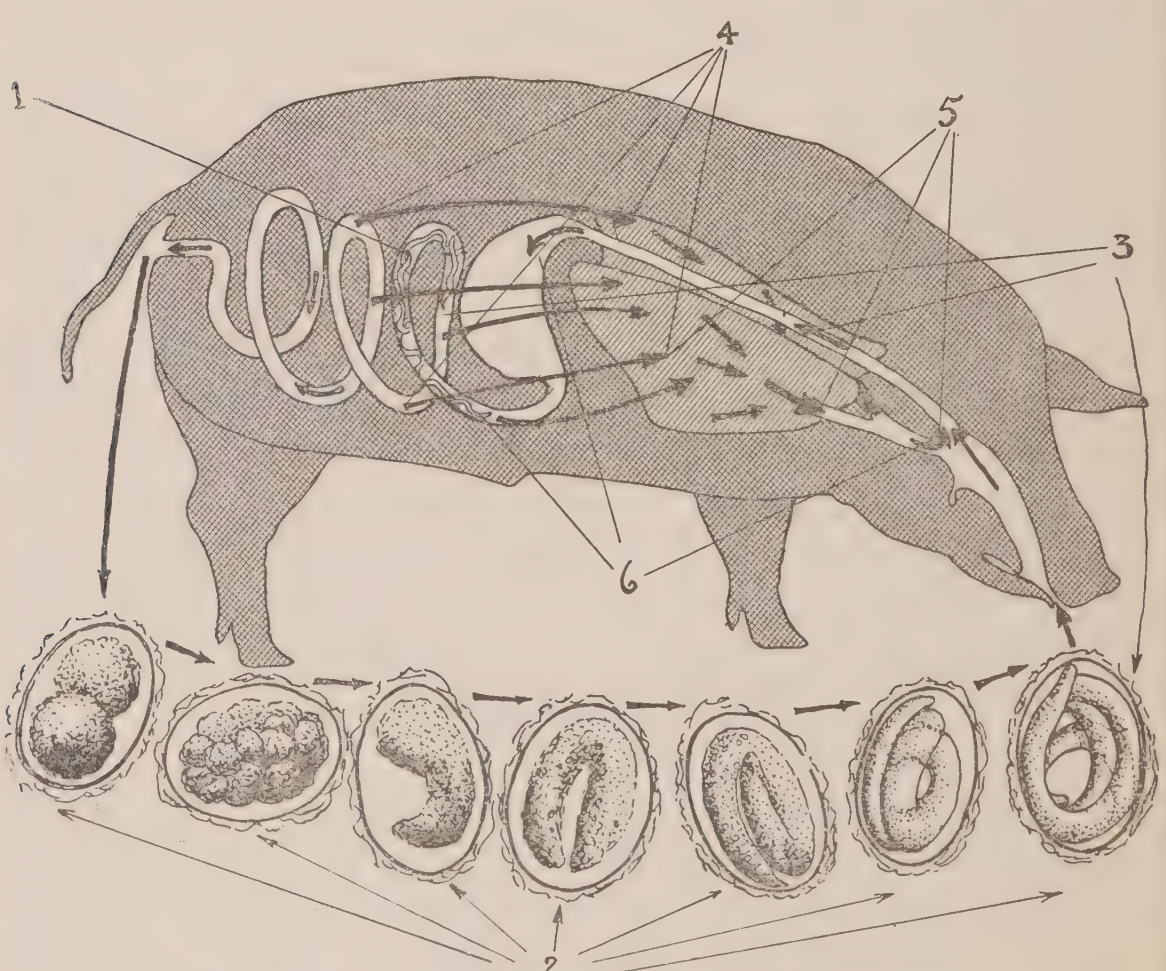

FIG. 21.—The life cycle of the Large Round-Worm.

until they are four months of age; and whatever pens they are moved into during these four months should be scrubbed and scalded before use.

Owners should beware of dirty pens, which may be coated with thousands of eggs of the parasite, and of paddocks, orchards, and yards used by generations of pigs, the ground of which is a store of millions of infective eggs.

III. *Disposal of Manure.*—The use of pig manure should, if possible, be confined to places to which the pigs will not have access. If this is impracticable, the manure should be well heaped up in some place where washing by rain, and draining on to the surrounding soil can be prevented. Lime or disinfectants should *not* be added, but the heap should be made compact, so as to have as small a surface as possible, and left for some time to allow decomposition to proceed. Before carting to the fields, the outside six or eight inches should be removed and set aside for inclusion in the next heap. The addition of horse manure greatly assists the decomposition process and hastens the destruction of the eggs.

IV. *Treatment.*—All effective worm medicines are dangerous and poisonous drugs, and are best left to the hands of a veterinary surgeon. They are quite ineffective against the young worms in the lungs and are too drastic in their action to be used in pigs less than four weeks old. The most effective drug in treating for this worm is oil of chenopodium; the dosage must, however, be carefully watched; and an adequate amount of castor oil should accompany or immediately follow its use, and neither food nor water should be given for three hours afterwards.

The Lung Worms of the Pig

Description.—Two species of Lung Worms commonly occur in this country, but in naked-eye appearance they closely resemble one another, being white, thread-like, and about 2 in. long.

Damage Caused.—These worms live in the small tubes of the lungs, where they cause an inflammation. If the infestation is not too heavy the result may be a bronchitis, as shown by a frequently repeated, husky cough. Where many worms are present this inflammation may extend to the lungs, and pneumonia result, which not infrequently causes death.

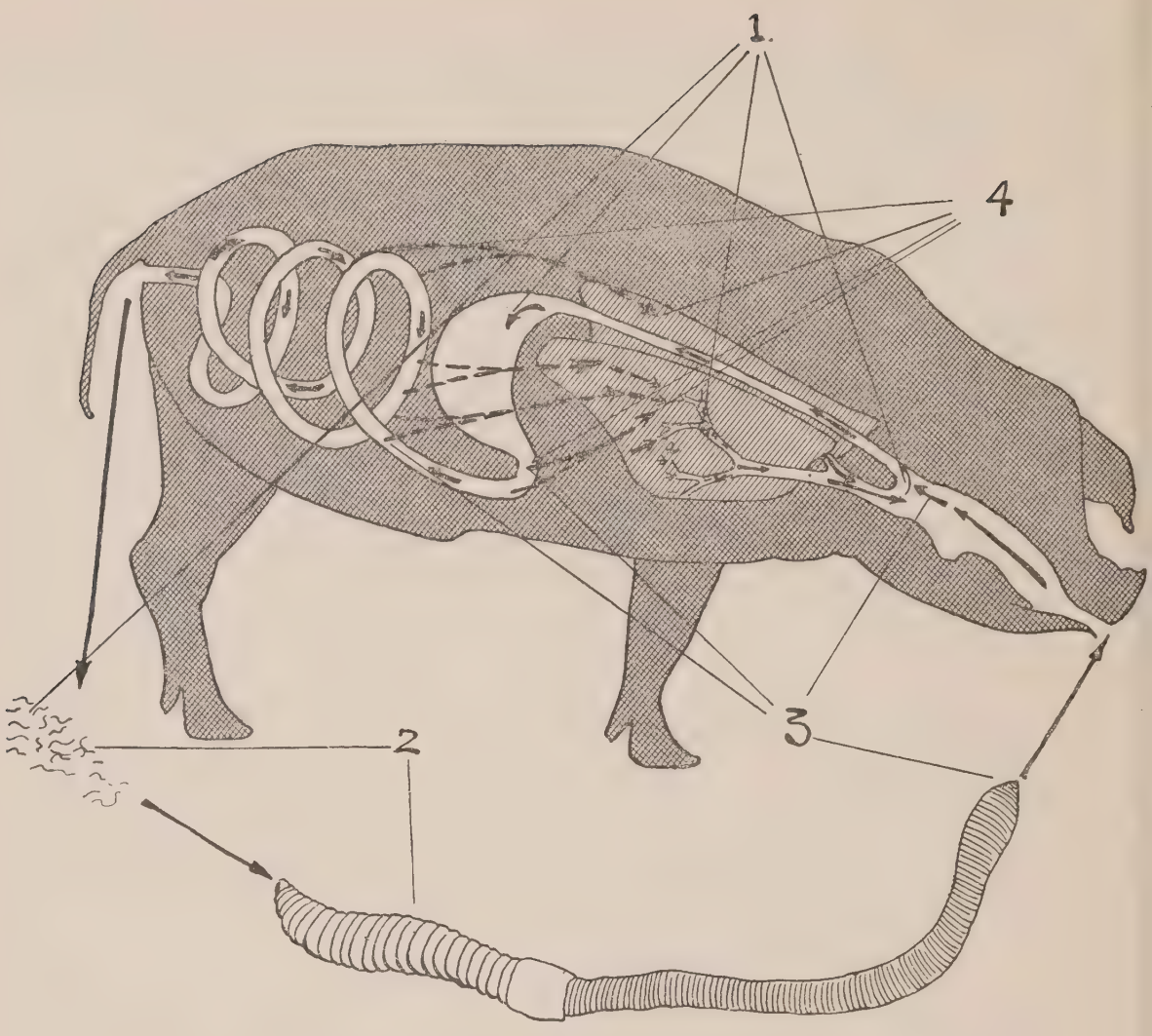

Fig. 22.—The life cycle of the Lung Worms of the Pig.

Life-History.—This is described with the aid of the diagram (Fig. 22).

1. Situated in the small tubes of the lungs, the female worms lay large numbers of eggs, which hatch almost immediately. The minute worms that come out of the eggs climb up the windpipe to the throat, are swallowed, and pass to the ground with the droppings.

2. These minute worms do not develop further unless they happen to be taken with the soil into the gut of an earthworm, where they are able to develop to the next stage. Only when they have completed their development in the earthworm are they ready to infect another pig. The presence of earthworms is therefore absolutely essential for the completion of the life history; and to this end the small kinds of earthworm are more suitable than the large one.

3. When the earthworm, which contains the minute lung worms, is eaten by a pig, these little worms are liberated in the pig's intestine, and bore through the intestinal wall.

4. Finally they are carried in the blood to the lungs, where they bore out of the blood vessels and make their way to the small air tubes; there they grow to mature lung worms.

Length of Time that the Lung Worm can Live in the Ground.—The longest time for which the larvae can lie in wait

in the earthworm is not known, but they are at least able to live through the winter, and in all probability much longer.

Prevention.—The general remarks that are given in connection with the prevention of the large round-worm apply to the lung worms, as also do the remarks on the disposal of manure. Where generations of pigs have access to small paddocks, or are kept in out-door pens with earth floors, the store of infective material in the earthworms there present will increase to dangerous proportions. Both of the special methods of extensive and intensive rearing advised for the control of the large round-worm are applicable. As will be gathered from the account of the life-history, however, any system of rearing pigs on clean concrete floors will completely control the lung worms, because of the absence of the earthworm which is necessary for their development. It cannot be too strongly urged that small paddocks and orchards, and dirty yards which have been overrun by pigs for years should not be used, since it is in such places that the earthworms are likely to be heavily infected.

Treatment.—No satisfactory medicinal treatment for this worm is known, but where the disease has appeared, the pigs should be immediately removed from the infected ground and placed in pens where earthworms are absent. This will completely prevent any increase in the number of lung worms, and liberal feeding will in time help the pigs to throw off those which are already present.

DESCRIPTION OF CERTAIN DISEASES OF ANIMALS

The following description of the diseases which are at present the subject of administrative action by the Ministry has been prepared by the veterinary officers of the Ministry with the view to assisting inspectors, as well as stockowners, in Great Britain, to detect those diseases.

Anthrax*—*Definition.*—A contagious disease caused by a microbe—*Bacillus Anthracis.*

Animals affected.—Human beings and all animals are liable to anthrax. The disease is seen chiefly in cattle, pigs, and sheep, but not uncommonly in horses.

Symptoms.—The disease shows itself suddenly. It is very fatal, usually within 48 hours. It does not often in the United Kingdom spread with rapidity from animal to animal, but it may affect a number of swine at the same time if they have been fed on anthrax flesh or organs.

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* For fuller information *see* pp. 12–17.

A beast which a short time before appeared to be well is found dead or in a dying condition. Frequently blood oozes from the nostrils and the anus. In cattle there are no typical symptoms, but in horses and pigs the region of the throat is often found to be swollen.

Post-mortem.—The carcass is swollen. Blood is found around the nostrils and anus. The muscles are often infiltrated with blood at certain points. The lungs and glands are congested. The spleen is very much enlarged; it is softer and darker than normal, and its substance usually resembles tar.

In most parts of this country the enlargement of the spleen is of great diagnostic importance, but in those districts where redwater exists, enlargement of the spleen may also be expected. In this case, however, the spleen substance has not the same fluid tarry appearance. The flesh is dangerous to animals and human beings. It is the height of folly on the part of a farmer to open an animal suspected to have died of anthrax, as he may thereby cause further infection of his premises. In cases of sudden death he should await a skilled opinion before disposing of the carcass.

Cattle Plague.—*Definition.*—A contagious and eruptive fever due to a specific filterable, ultra-microscopic virus.

Animals affected.—Bovines, rarely sheep, camels, certain wild ruminants, and occasionally swine.

Symptoms.—The temperature rises in the early stages. The animal is off its feed, dull, and the coat is staring. Sometimes shivering is noticed. The breathing is quick; a watery or mucous discharge flows from the eyes and nostrils; in the latter case there may be a slight amount of blood in the discharge. In milch cows the secretion of milk is diminished or arrested. The membrane of the nostrils is reddened, and an eruption, like grains of bran, appears at the lower parts. This eruption is often followed by distinct ulceration, which may appear in the nostrils, inside the lower lip, and on the tongue. The bowels are at first constipated, but in the later stages diarrhœa often sets in. In this case the dung has a foul smell, and is often tinged with blood. The animal falls away rapidly, and the disease usually has a fatal termination in from six to ten days.

It does not attack single animals in a herd, but spreads rapidly from one to another.

Post-mortem.—The lungs are congested and often contain fluid. Congestion and ulceration of the fourth stomach are present. Congestion of the bowels, which gives place in the later stages to a greyish deposit on the mucous membrane

and to ulceration, is also seen. The lymph glands are dark red in colour. The flesh is of a dark mahogany colour; it putrefies rapidly, and should not be used for food. The carrying about of the flesh by dogs and birds helps to spread the disease.

Foot-and-Mouth Disease.*—*Definition.*—A contagious and eruptive fever, due to a specific, filterable, ultra-microscopic virus.

Animals affected.—All animals may suffer from this disease, but cattle, sheep, and pigs are especially liable. Occasionally human beings are affected.

Symptoms.—In cattle, sheep, and pigs the disease begins suddenly and spreads with alarming rapidity. It is not a very fatal disease, but stock lose condition when attacked.

The temperature rises. The animal smacks its lips and saliva drips from the mouth. Sometimes lameness is the first symptom noticed. In cattle, vesicles (blebs) are found inside the upper lip and on the tongue. The surface under the vesicle is red. The vesicles also appear between the toes and on the teats of the cow. They seldom appear on the body except in the pig. The milk from affected cows conveys the disease to other animals and to human beings, and its use is governed by the provisions of the Foot and Mouth Disease Order of 1928.

Glanders and Farcy.†*—Definition.*—These two names are applied to one and the same disease, which is due to a microbe—*Bacillus Mallei.* The disease is called "farcy" when located on the surface of limbs or body; "glanders," when the principal symptoms are seen in the nostrils, submaxillary glands and lungs.

Animals affected.—The horse tribe is most commonly affected with glanders. Man not infrequently gets the disease from the horse by inoculation through a wound. The dog, the cat, and the wild carnivora may be infected. The ox is absolutely immune. Sheep, goats, and pigs are immune for all practical purposes.

Symptoms.—A horse may be affected with glanders and show no symptoms except slight unthriftiness. This is called occult glanders, and can be diagnosed only by the mallein test.

In typical clinical cases there is a thick grey-coloured discharge from one or both nostrils. Ulcers and ulcerous patches are seen inside the nasal cavities, and the glands under the jaw

* For fuller information *see* pp. 35–40.
† For fuller information *see* pp. 49–51.

are enlarged and hard. The temperature may be raised, but in chronic cases it may be no higher than the normal. In severe and acute cases the temperature is several degrees above normal, and the animal shows distinct symptoms of respiratory disease. In farcy one or more limbs become swollen. The lymph vessels stand out prominently on the inside of the limbs. The vessels give a cord-like feel to the hand, and small nodules appear along the course of the vessels. These nodules frequently burst and become ulcers, which discharge a thick yellow fluid of oily appearance. The ulcers may heal and leave a scar, but they usually break out again. Farcy may also appear on the skin of the neck and body.

Post-mortem.—If farcy has been present the ulcers are seen on the skin. Besides what one sees in the live animal one may also find ulceration of the throat and air passages. The most constant changes are, however, found in the lungs. In acute glanders, small grey nodules about the size of a pin-head are seen all through the lung substance. In the chronic forms the nodules in the earlier stages appear as small, grey patches with a red margin. Others are of pus-like consistence. The older nodules are hard and shot-like to the touch; some of them are gritty—calcification. The number of nodules in a lung varies from one or two to hundreds. The donkey suffers from an acute form of glanders, in which the lungs are inflamed over a large surface. The tissue is solid, and on section the surface of the lung has a greyish-red colour.

Epizootic Lymphangitis.—*Definition.*—A contagious and eruptive disease caused by the *Cryptococcus Farciminosus.*

Animals affected.—Horses and mules. The ox is susceptible, but seldom takes the disease under natural conditions.

Symptoms.—The eruption appears on the legs, the neck, the head, or any part of the body. Usually it starts near a wound through which the microbe has entered the tissues, but the ulcers often do not appear for months after the wound has healed. The lymph vessels in the skin stand out prominently, and small hard nodules about the size of a hazel-nut appear on their course. These nodules suppurate and discharge thick yellowish pus. Proud flesh grows from the wounds, the lymph vessels around become inflamed, and the eruption gradually extends. A thick yellow scab may form over a patch of ulcers. The neighbouring glands are swollen and hard. The ulcers heal with difficulty, even under treatment, and they may break out again after an apparent cure has been effected.

The ulcers may appear inside the nostrils, but this is not so common as in the case of glanders. In epizootic lymphangitis the glands under the jaw may also be enlarged, as in the former disease, and a discharge may appear at one or both nostrils. If taken in the early stages this disease is curable, but after an advanced stage is reached, treatment is hopeless. In the latter case the animals emaciate and may die of exhaustion.

This disease is distinguished from farcy (glanders) by the presence of the cryptococcus in the pus, and failure of the mallein test to produce a reaction. Both glanders and epizootic lymphangitis may be present in the same animal.

Post-mortem.—On post-mortem examination one usually sees little beyond what is seen during life, but occasionally abscesses are found in the internal organs.

Mange in Horses, Asses, and Mules.*—*Definition.*—The same definition may be applied here as in Scab of sheep. The disease is the same, except that it is caused by different varieties of acari.

Sarcoptic and psoroptic mange in horses and mules often begin on those parts of the body to which the harness is applied, but they extend to other parts if neglected.

Symptoms.—Sarcoptic mange is the more serious, as it does not yield readily to treatment. The animals rub themselves, and express satisfaction by moving the lips when scratched. Pimples and scabs appear at the seat of the disease, and the hair gets rubbed off. In neglected cases the skin becomes hard and folded, the animals emaciate, and they may die of exhaustion.

Symbiotic mange appears at the root of the tail and on the lower part of the limbs. The symptoms are not severe, but the animals suffer a good deal of irritation, which they express by rubbing the tail and stamping the feet. Sometimes they seriously injure the coronets by tramping on the itching part.

NOTE.—Only two forms of this disease—sarcoptic mange and psoroptic mange—are required by the Parasitic Mange Order of 1911 to be notified.

Pleuro-Pneumonia.—*Definition.*—A contagious disease affecting the lungs and pleura, and due to an infective agent.

Animals affected.—Bovine animals.

Symptoms.—The first signs of disease often escape notice. The temperature rises. A dry, husky cough is present, especially when the animal first gets on its feet or when made to

* For fuller information *see* pp. 72–80.

run. In marked cases the breathing is rapid, and the movement of the flanks is increased. If punched in the ribs, the animal may grunt or show signs of pain. Some of the affected animals may become greatly emaciated, but others, especially those which have passed the acute stages, may appear to be in excellent condition. It does not follow, however, that the latter are cured; they continue to infect others for a very long time.

Post-mortem.—The chest cavity often contains a yellow fluid. The lungs may be fixed to the ribs by a thick yellowish membrane.

The lungs are very solid in parts, and the surface is often yellow. The cut section is marbled in red and yellow. The septa (or fibrous tissue lines) are very broad, and a yellow fluid exudes from the cut surface. In old cases a grey area of soft dead tissue is often present in the lung, and this may be surrounded by new fibrous tissue. Sometimes abcesses are found. The flesh may be quite good and fit for food if the animal has been slaughtered. In the acute stages, however, and in emaciated animals, it is watery, of poor quality, and should not be eaten.

Rabies.—*Definition.*—An inoculable disease caused by a still undiscovered agent.

Animals affected.—All animals and human beings may suffer from rabies if the virulent material be inoculated, but it is chiefly by the dog that the disease is spread. In countries where the disease is prevalent, cases not infrequently occur among cats. In human beings the disease is called hydrophobia.

Symptoms.—The disease is characterized in the earlier stages by maniacal symptoms, and later by paralysis.

A dog is observed to change his former habits. He is restless, and often seeks dark corners, or wanders away from his home in an aimless way. He will sometimes snap at persons, other animals and inanimate objects (furious rabies). He may also foam at the mouth. He will tear up and swallow such articles as wood and cloth; in fact, it sometimes happens that attention is drawn to his condition by the lodgment of a sharp object in his throat.

The voice becomes altered to what might be described as a weird howl.

In the later stages paralysis sets in (dumb rabies), which first affects the lower jaw, but may ultimately show itself in

the limbs. The jaw drops, and saliva, which the dog is unable to swallow, trickles from the mouth.

Persons are sometimes inoculated by getting the saliva on the fingers and unwittingly rubbing it into the eyes or scratches.

It should be noted that the saliva has been found virulent in experimentally inoculated animals three days before the appearance of even the premonitory symptoms.

Post-mortem.—The post-mortem appearances are not constant. For this reason the head of a suspected dog should be immediately sent to the Ministry's Laboratory, so that inoculations may be made with the brain substance.

The principal changes observed are congestion of the membrane of the throat, and a similar condition in various parts of the stomach and bowel. The stomach may be quite empty except for a variable quantity of blood-stained mucus. If, however, the dog has been killed in the earlier stages the stomach may contain a mass of foreign material such as wool, hair, wood, coal, &c.

Sheep-Pox.—*Definition.*—A contagious eruptive fever caused by a specific filterable, ultra-microscopic virus.

Animals affected.—Only sheep are liable to contract this disease. The possibility of its being re-introduced is remote, because—although an inoculable disease—it has never appeared in this country otherwise than by the importation of diseased living animals, and the Orders of the Minister prohibit the landing in Great Britain of sheep from those countries in which sheep-pox exists. It might, however, arise from the importation of virus.

Symptoms.—Sometimes the disease runs a very rapid course, which ends fatally in a few days. This form of the disease is seen mostly in lambs. The chief symptoms are those of fever, intoxication, and paralysis. An eruption in the form of red spots appears on the membranes of the eyes and nose, and on the hairless parts of the skin.

In older sheep the disease begins by signs of serious ill-health. The temperature is high and the appetite is suppressed. An eruption appears on the mucous membranes of the nose, eyes, and mouth, and on the hairless parts of the skin—inside the thighs and elbows, under the belly, on the scrotum and udder. The eruption may, however, appear also on the parts of the body covered by wool. On the hairless regions it shows itself first in the form of small pimples, which may grow to the size of a sixpenny-piece or even larger. The larger pimples are flattened on the surface, and the skin around the

base is reddened. A thick reddish-yellow discharge oozes from the pimples, and forms a yellow crust on the surface. Pregnant ewes often abort.

Post-mortem.—One finds the above-described eruption on the skin. The membrane of the throat is inflamed, and sometimes ulcerated. The covering membrane of the lungs shows red spots on its surface.

Solid grey patches are often found in the lung substance. The cavities of the chest, heart sac, and abdomen contain a reddish-coloured fluid. The intestinal membrane is sometimes inflamed in patches.

The kidneys often show grey patches under the capsule.

Sheep-Scab.*—*Definition.*—A disease of the skin caused by certain members of a class of small insects known as acari.

Animals affected.—Scab is popularly known in animals other than sheep as mange. The parasites which cause mange belong to the same family as those which cause scab, but they are a different variety. In sheep three forms of scab are met with. Psoroptic scab, due to the "*Psoroptes communis,*" is the most common form found in sheep. Sarcoptic scab or mange, due to the "*Sarcoptes scabei,* var. *ovis,*" occurs in sheep, but it is rare.

Symbiotic (scab) mange is also known.

The sarcoptic parasites will live on other animals and on human beings. They cause severe symptoms; the other parasites only live on man for a few days, causing temporary irritation.

Symptoms.—Psoroptic Scab.—The first symptoms may appear in about three weeks after infection, but this interval is frequently much longer, especially in cases where single dipping or careless double dipping has taken place since exposure to infection. Cases are not uncommon in which the incubation period is protracted beyond six months, the sheep exposed to infection in the spring may show no visible symptoms of the disease until the following autumn or winter.

One of the first symptoms apparent in a sheep that has contracted scab is restlessness combined with a desire to bite the affected part or to rub against posts, fences, hurdles or even other members of the flock. This restlessness is the result of the irritation produced by the parasites pricking the skin of the sheep in their endeavour to obtain food. The constant biting and rubbing of the sheep to allay the irritation causes injury to the skin. This is followed by the exudation of lymph

* For fuller information *see* pp. 92–98.

and the formation of crusts or scabs under the edge of which the parasites and their ova are to be found. As the parasites increase in number they move from the scabs to the more healthy parts of the skin, and thus extend the area of the diseased parts. The injury to the skin is followed by shedding of the wool and the fleece becomes broken and tufted, or matted together, giving the animal a ragged appearance. Even where the wool does not detach itself from the skin it assumes a dead-white, bleached appearance.

The parasites may often be seen moving under a magnifying glass if a scraping be taken from the diseased patches and placed in the sun.

Sarcoptic Scab.—Sarcoptic scab in sheep appears on the head and ears. Sometimes it is seen on the tails of large-tailed sheep. It gives rise to a formation of thick yellow crusts.

Symbiotic Scab.—Symbiotic scab appears usually at the lower parts of the limbs, about the pasterns and coronets and at the base of the tail. The symptoms are not severe, but the animals rub their legs and tails and the wool becomes broken.

Swine Fever.*—*Definition*—A contagious eruptive disease caused by a specific virus.

Animals affected.—Swine.

Symptoms.—The disease may come on rapidly, especially in young pigs. This is the acute form, which generally ends fatally in about three days. The symptoms are less definite than in chronic cases. The temperature is high—103° Fahr., or even higher. The breathing is quick; the pigs seem to have lost control over their hindquarters, and stagger if made to walk. A red rash appears on the skin at the base of the tail, under the belly, inside the thighs, and on the ears.

Usually the symptoms come on more slowly. The pigs appear to be dull; they lie under cover and are disinclined to move. The appetite is lost; frequently the animals vomit. Constipation, followed by diarrhœa with blood-strained fæces is often observed. A mucous discharge may be present around the eyes. Red patches, which later on assume a violet tinge are observed at the base of the tail, inside the thighs and hocks, under the belly, and on the ears. The temperature is high—104° to 106° Fahr.

The pigs can be roused only with difficulty, and when made to move they stagger about as if inebriated. Very frequently lung symptoms are present. In this case sick animals suffer from a short cough, and the breathing is very laboured.

* For fuller information *see* pp. 122–127.

The lung symptoms are not necessarily due directly to swine-fever, but they frequently accompany it and one must always be suspicious if a number of pigs show signs of lung trouble. The animals die in from one to three weeks. They may, however, recover, or drag on for two months or more in an emaciated condition. In countries where the disease has been long established, an affected animal sometimes appears to be in normal health.

Post-mortem.—The carcass is generally emaciated. The discoloured patches on the skin have a livid hue, but this is also seen in other diseases of swine.

In acute cases followed by rapid death, the changes are not characteristic, but one's suspicions should be aroused if a number of swine become sick about the same time. In the more chronic cases the most characteristic change—ulceration—is found in the alimentary tract. The ulcers may be present on the tongue, the stomach, or any part of the bowel, but in most cases they are confined to the more posterior portions of the last named, particularly around the junction of the ileum with the caecum.

The most typical ulcer is about the size of a threepenny-piece. Its edges are circular, and raised above the membrane. The centre of the ulcer is soft, and often yellow or black in colour. The other parts of the bowel may be inflamed, and often the inner surface is covered by a yellowish deposit. Two loops of bowel may have grown together.

The lungs are very often, though not always, solid in patches, and fluid may be present in the chest. The glands are very red in colour in the more acute cases.

Tuberculosis.*—*Definition.*—A contagious disease caused by a microbe—the *Bacillus Tuberculosis.*

Animals affected.—Human beings and most species of mammals and birds are liable to tuberculosis. Amongst the domesticated animals cattle, particularly dairy cows, and swine are most frequently affected; sheep very rarely.

Symptoms.—Sometimes not characteristic, the disease being often of a mild chronic nature. In advanced cases there is usually emaciation, when the lungs are affected there may be a chronic cough with disturbance of the respiratory function. In cows lesions in connexion with the udder are sometimes present. The udder, usually in one of the posterior quarters, becomes the seat of a hard swelling of slow but steadily progressive growth—the swelling is usually almost painless.

* For fuller information *see* pp. 127–131.

The milk from the affected quarter at first appears normal, then becomes thin and watery, and later becomes flaked. Microscopic examination of milk from the diseased quarter shows the presence of tubercle bacilli.

During life the existence of the disease may be detected by means of the tuberculin test.

Post-mortem.—The characteristic lesion caused by the tubercle bacillus is a particular form of degeneration called caseation. The tissue affected becomes converted into a cheesy mass. Nodules of varying size may be present in the lungs, liver, kidneys, in lymphatic glands in various parts of the body, in the uterus, udder, pleura, peritoneum, membranes of the brain, &c.

NOTE.—*Certain forms of this disease are made notifiable by the Tuberculosis Order of* 1925 (*see p.* 130).

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